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Group of Reinforced-Concrete Buildings for a Wood Distillation Plant, Donald, Ont.

At Donald, Ont., the center of a large timber district, there has just been completed, for the Wood Products Co., Ltd., of Canada, an entirely new plant for the destructive distillation of wood into alcohol, with acetate of lime and charcoal as by-products. In this plant particularly are utilized the birch, beech and maple which for timber purposes have small value, but which can be used to great advantage in wood-distillation. It is reported that for every cord of wood there is produced eight gallons of wood alcohol, 200 lbs. of commercial lime acetate, and 52 bushels of charcoal.

As the plant was designed and erected as an integral construction, great economy was possible in arrangement of the various parts and in their construction. So far as possible reinforced concrete was used throughout. The group of structures (see Fig. 2) comprise four buildings—oven house, still house, charcoal house and boiler house—a 50,000-gal. water tower and a concrete dam across the Burnt River. All of the buildings are of reinforced-concrete framework, floors and roof, with sand-lime brick curtain walls. From the contractor we are able to present the following description of these various structures:

The boiler-house is 52 × 90 ft., one-story high, with monitor roofs as shown in the photographs of all the buildings. (Fig. 1.) A battery of four 150-HP. boilers, bricked in with sand-lime brick, will supply the steam required for the working of the plant. The fuel to be used in these boilers is the soft and refuse hard wood from the adjacent limits, also the large quantities of marsh gas and wood tar driven off from the retorts during the destructive distillation process. The boilers are located in the north end of the boiler-house; large wood storage space is immediately in front of the boilers, and large openings in the boiler-house walls are provided to pass the wood through. These openings are closed with rolling steel shutters. At the side of the boiler-room is the power and producer gas room, in which are a 125-HP. gas engine, a large triple-acting pump, and a 1,000-gallon pump. The pump is driven by belt from the gas engine, which is also direct connected to a generator for supplying the entire plant with electric light and current for operating small motors in connection with pumps and other light machinery. The engine is supplied with gas from a producer gas plant. Refuse charcoal braize which is accumulated during the handling of the charcoal in the ovens as a result of the destructive distillation process is used in the producer. This charcoal braize is stored in a reinforced-concrete bin in the side of the producer gas room.

The oven-house, 78 × 109 ft. in plan, contains a battery of four pairs of twelve-cord ovens, six cords to each retort. Retorts, ovens, trackage, turn-tables and coolers are laid out in the customary manner where single ended retort ovens are used. The building itself offers some interesting features in connection with the structural side of the work. The entire roof work is carried by six reinforced-concrete columns resting on arched or divided footings standing between the ovens. These divided footings were designed to open up passageways for the workmen from one side of the oven-house to the other between the ovens.

At the line of the first of lower roofs of the oven-house (Fig. 3) the beams for the wide span roof are handled in a peculiar manner, as the ventilating stacks standing over the front of the ovens centered on the division line between the pairs of retorts. To escape these stacks and to give a structure for this roof, in which the beams would have practically uniform loading, the main girders were split and carried, as shown, into alternate pairs carried by single columns. This worked out with great success in the actual construction of the work. On the opposite side of the roof, where the stocks leading from the ovens are also centered on the same central lines as the ventilating stacks at the front of the ovens, a modification of the roof system as shown was here introduced. The central portion of the oven-house with a span of 35 ft. was carried by three large girders resting upon the six concrete columns above mentioned, making a room over the tops of the ovens 32 ft. wide and 107 ft. long, clear of any supports interfering with the use of the floor over the ovens for the purposes for which it was designed, that of evaporating the liquid from the lime acetate. The floor is connected with an acetate storage house of galvanized iron at the north end thereof, and by stairways with the lower levels of the oven-house.

The charcoal by-product is pulled from the retorts into steel coolers facing the retorts. From these coolers the charcoal is pulled into the open air, to be absolutely sure that no traces of fire are remaining. Finally, as shown on the general plan (Fig. 2), the trackage from the coolers extends into the charcoal house through doorways especially provided therefor, and the cars are there unloaded for storage. The charcoal cars are drawn through the coolers and into the charcoal house by an electric winch embedded level with the floor, the head of the winch standing up about 2 ft. This winch is centrally located in the charcoal house and handles the cars to the best possible advantage.

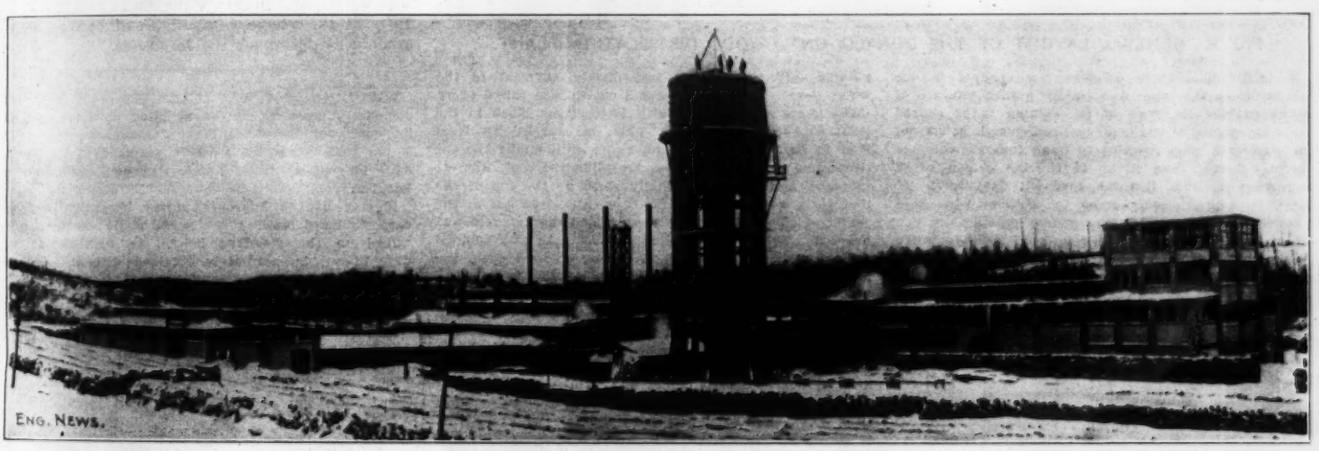


FIG. 1. VIEW DURING CONSTRUCTION OF PLANT OF THE WOOD PRODUCTS CO., DONALD, ONT.

The charcoal house itself furnished no very peculiar structural features. The building is 45 × 110 ft. in plan with the roof girders carried on a central line of columns and on exterior wall columns. The walls of the monitor roof are carried by these cross girders by longitudinal beams framed into the girders at the inner third points. A maximum of light at the point required, as well as a comparatively clear floor space is thereby provided. The charcoal will be handled eventually by this house by a system of elevators or conveyors.

The still-house, south of the boiler-house, the most elaborate of any of the buildings, is 73 ft. wide × 120 ft. 6 ins. long and contains the neutralizing room, tank room, main distilling room and refinery, the four-story part being the refinery. The raw products of distillation are pumped from the collecting tanks in the oven-house to the still-house settling tanks, and from the settling tanks, forward through the various processes of neutralizing and distillation. It is expected that the final output from the still-house will be of the very highest grade of wood alcohol possible to produce. The final refining of this will not be done at present at this plant, but will be forwarded to Montreal to a wood alcohol refinery at that point. Until the complete refining plant is installed, the output will be only 92% alcohol.

The structural features of the still-house present some interesting points. (Fig. 5). At the north end of the still-house it was necessary to provide an exceedingly strong floor system to carry four 10,000-gal. tanks for holding raw liquor, at an elevation of 14 ft. 6 ins. above grade with an ample factor of safety. At

the opposite end of the still-house in the refinery, openings 9 ft. 6 ins. in diameter are left in the floors for the final alcohol stills to pass through. These floors have been figured for a safe loading of 450 lbs. per sq. ft. on the second, and 350 lbs. per sq. ft. on the third and fourth floors, respectively. In the center or main room of the still-house it was necessary to carry the roof on some very high columns, 22 ins. in diameter and

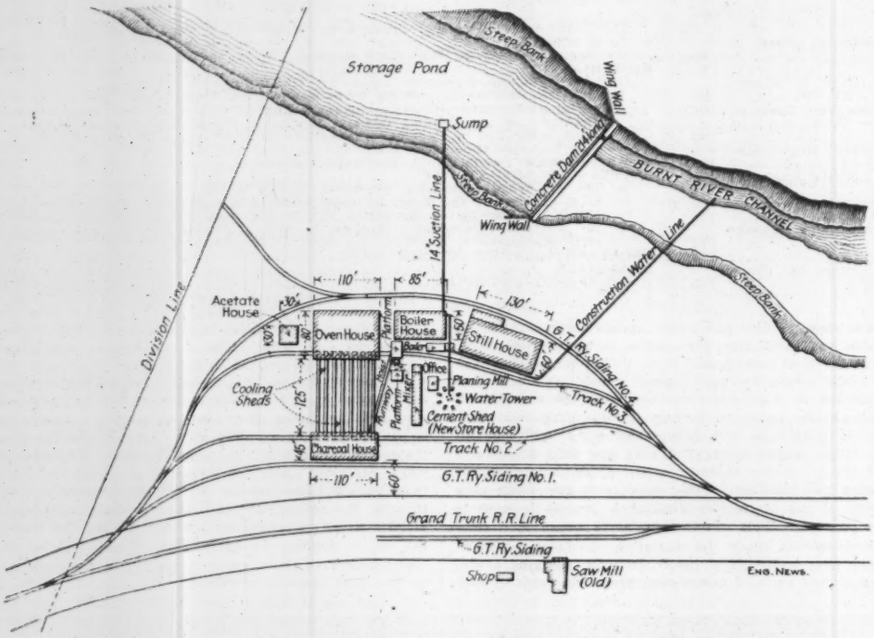


FIG. 2. GENERAL LAYOUT OF THE DONALD, ONT., WOOD DISTILLATION PLANT.

23 ft. in height. These columns were poured in one operation from the top. A specially graded mixture of concrete enabled the base of the column to be poured without separation of the aggregate. Although it has not been considered good practice to pour concrete columns at greater height than 12 or 14 ft., the exigencies of construction in this instance made it inadvisable to attempt to pour these columns in separate runs, and the finished work justified the course pursued.

The water tower is the first reinforced-concrete water tank resting on a high tower of openwork construction which has been built in Canada. In developing the

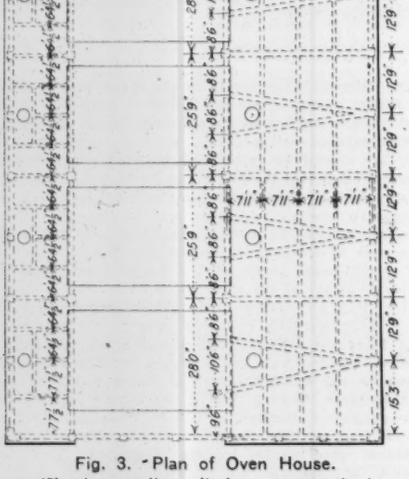


Fig. 3. Plan of Oven House.
(Showing peculiar split beam construction.)

plans it was early decided that the supporting legs should be carried down vertically the full diameter of the tank and without any batter. To give the requisite stability and spread the footings, a buttress type of column was used in the first story. During the process of construction the originally designed square central hollow column was changed to four 16-in. columns standing at the corners of the original box column. The spaces between these central columns are to be bricked up with a hollow brick wall to form a frost-proof box for the water pipe.

The tank is of 50,000 gals. capacity and stands from grade line to top of the roof 93 ft. in height. Use was made of the space between the four central columns above mentioned as a hoistway. Hoisting was done with a small belt-driven drum attached to a shaft in the planing mill, which was immediately adjacent to the water tower. A load of about 8 cu. ft. was raised every three minutes. A tripod with 14-in. boom block in the peak supported the hoist. This was carried up from floor to floor as the work progressed until finally the entire frame work of the tank, including the roof, was set in place, and the tripod finally stood on the top of the roof form work. A 3-ft. square opening was left at the center of the roof form, through which the concrete was handled. The bucket holding the concrete was dumped on the peak of the roof, and concrete flowed down the slope, dropping into the side walls of the forms in a very satisfactory condition. The pouring of the tank was continuous for over 36 hours. It may be interesting to note that the temperature during this time dropped to 9° F. Part of the time it was found desirable to heat the materials to some extent. However, the job may be considered eminently successful.

As shown by the details of steel in the water tank (Fig. 4), twisted steel bars were used almost exclusively in connection therewith. Modifications were made in this detail in that instead of the two lines of twisted steel shown in the lower portion of the tank, these two lines were merged into one line resting more nearly at the center line of the tank walls. The walls and floor of the tank were 12 ins. thick, which will, perhaps, be considered by some to be unnecessarily thick, but the thickness was decided upon by the engineer as providing a more complete prevention of seepage.

A concrete dam 214 ft. long, exclusive of the wing walls, for carrying a normal head of about 9 ft. of water was thrown across Burnt River to give water for cooling the stills. Consideration was given to the amount of flood water annually sent down through the valley of the Burnt River, and the dam was figured for a flood of 1 ft. in height throughout the entire length. In the construction of the dam, it was found that the bed rock it was intended to rest upon sloped off deeply at the north end and was approximately 24 ft. below the normal heel as designed. It had been the intention to carry a concrete cut-off wall entirely to bed rock, but on this portion at a level of approximately 16 ft. below the normal heel a bed of very fine compact sand was encountered into which sheet piling was driven several feet, and the dam was not carried down to rock. At the normal spillway the entire dam is founded on rock. Reinforcement of twisted bars was incorporated into the body of the dam, especially at the point where the footings became floating, to prevent the possibility of structural cracks, and no structural cracks have occurred at this point, although already tested by unexpected flood conditions before finally completed. The storage lake formed by the dam is approximately 1½ miles long, with an average width of about 400 ft., and an average depth of 4 ft.

In the concrete on the work a lime[illegible] from near Fenelon Falls, Ont., was used, a [illegible] flinty stone with very little dust and a semi[illegible]ttered, semi-conchoidal fracture. This stone w[illegible]rushed to 2½ ins. for the foundations and in [illegible]super-structure to two grades, the first passi[illegible]¾-in. mesh, the second a 1-in. mesh; the tw[illegible]es in combination with local sand made a v[illegible]ense aggregate. The foundation mix was [illegible]; the superstructure 1:2:4 and the dam 1:2[illegible]. The reinforcement of beams was made of [illegible]agara bars, which are formed from commerci[illegible]uares and flats, with attached flat diagon[illegible]shear wings. The floor slabs were reinforced [illegible]h the special chain mesh, made by the Onei[illegible]Com-munity, Limited, known as Community Chain Reinforcement. This consists of wires in [illegible]e di-rection, crossed and held at the intersection by specially shaped chains. The columns were rein-forced with longitudinal round rods hooped with spiral bonding.

The contractor's plant centered around the concrete mixer, which was driven by boilers fed from the nearby river. From this mixing plant runways led to the various buildings and the concrete was carried thereto in barrows. In connection with the work a fairly well equipped saw-mill and carpenter shop was run and all of the forms were made on the ground, mostly out of the hemlock of the surrounding woods, although for the fine work some pine was used. The hemlock served very well for one using, but there was little salvage from it, so the form-work cost ran quite high.

The plant was erected under the charge of Mr. William H. Oliver, Toronto, Ont., with Mr. J. M. Wilson, Toronto, as his assistant on construction. The contract for the entire erection was let to Pitt & Co., of Niagara Falls, Ont., and Mr. E. D. Pitt, of the above company, had charge of the structural design of the buildings.

WEIGHING RAILWAY CARS.—There is very little dishonesty practiced in the handling of weights of car-lot coal, but there are many inaccuracies. . . . The 50-ton coal car loaded gross to as much as 156,000 lbs. calls for jam-up track scales, well set, maintained and handled.

It may not be improper to say here that with coal cars equipped with the vertical-plane coupler, maintained to the standard height as required by law, weights can be accurately obtained without uncoupling

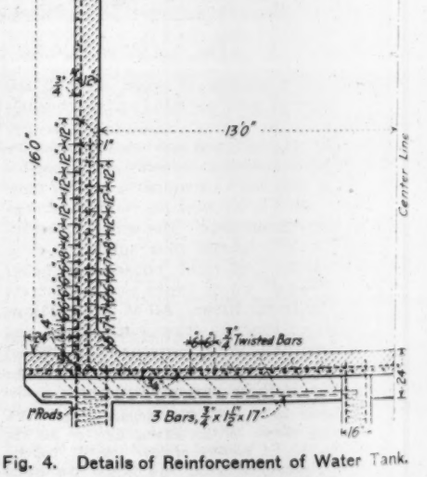


Fig. 4. Details of Reinforcement of Water Tank.

at either end. I have demonstrated this by a dozen separate tests including several hundred cars, and as a result of these investigations, personally made, stand committed to the belief that cars when cut at one end can be weighed with accuracy providing they are stopped on the scale, this position insuring correct weights with the minimum expenditure of time and expense.—C. McAuliffe, Genl. Fuel Agent, Rock Island-Frisco Lines [Western Railway Club, Jan., 1909.]

Report of the Waterways Commissioner of Wisconsin.

In 19[illegible] Wisconsin Legislature created the office of [illegible]erways Commissioner and Hon. Ray S. Reid [illegible] appointed to that office. His report, recently [illegible]ented, discusses the subject in such an orig[illegible] manner and presents so many new points of [illegible]iew concerning the improvement of navigable rivers that we have thought it worth while to reprint a considerable portion of the report below. Some comments on the report will be found on our editorial page. Mr. Reed says:

Since my appointment as Waterways Commissioner I have spent many months upon the Mississippi River and its tributaries, have traversed the entire navigable length of the Elbe, Moldau, Rhine, and Seine Rivers, the Danube River from Budapest to Regensburg, have visited the Rhone River and all the navigable rivers of England, Scotland and Ireland, and have also visited many of the best known canals in Western Europe, and as I had spent the greater part of more than a year previous to my appointment in a study of the theoretical questions involved in the improvement and operation of rivers, I feel certain that ample and convincing proof can be made of the statements and conclusions contained in this report.

Conclusions.

(1) The Mississippi River between St. Paul and St. Louis is capable of being, and has been, improved in a higher degree than any other part of the Mississippi, or any of its tributaries.

(2) The Mississippi River below the mouth of the Missouri is practically incapable of any improvement, except at a cost far in excess of the actual value of such improvements.

(3) The tributaries of the Mississippi can be used to a very great extent, and with economy, for the transportation of certain classes of freight, without any improvement whatever.

(4) There is no economy in the transportation of freight up the Mississippi River or any of its tributaries by the methods of operation in vogue on those rivers.

(5) There is no economy in transportation on canals, if the cost of construction, maintenance and operation are taken into consideration.

(6) If modern methods of operation were put in use, on the Mississippi River and its tributaries, such rivers can be made the most economical means of transportation in their present condition, that can be found within the borders of the United States.

(1) Coming to the reasons for the first conclusion above set forth, it has been demonstrated by the engineers in charge of the improvement on that part of the river lying between St. Paul and the mouth of the Missouri River that it is capable of being confined within certain limits, which has greatly improved that part of the river for steamboating purposes.

The banks of this part of the river are composed of very substantial material, and are easily protected by revetment where any protection is necessary, and that is in a comparatively slight part of the river. There is now a channel of at least 4 ft. in depth capable of being maintained over the whole of this part of the river, with the aid of storage reservoirs now in operation at the head of the river, except perhaps in one or two places, and it may be possible to create a channel 6 ft. in depth over this part of the river, if it were necessary for the purpose of economical transportation to do so.

(2) I am firmly convinced that no reasonable expenditure of money can ever make any improvement of the channel of the river, at times of low water, between the mouth of the Missouri River and the Red River. There the bank of the river is composed of light material and it seems almost as though it dissolves at times. The experience of railroad companies in attempting to protect short stretches of bank of this character is not only interesting but instructive, and I will cite a few incidents which have occurred lately.

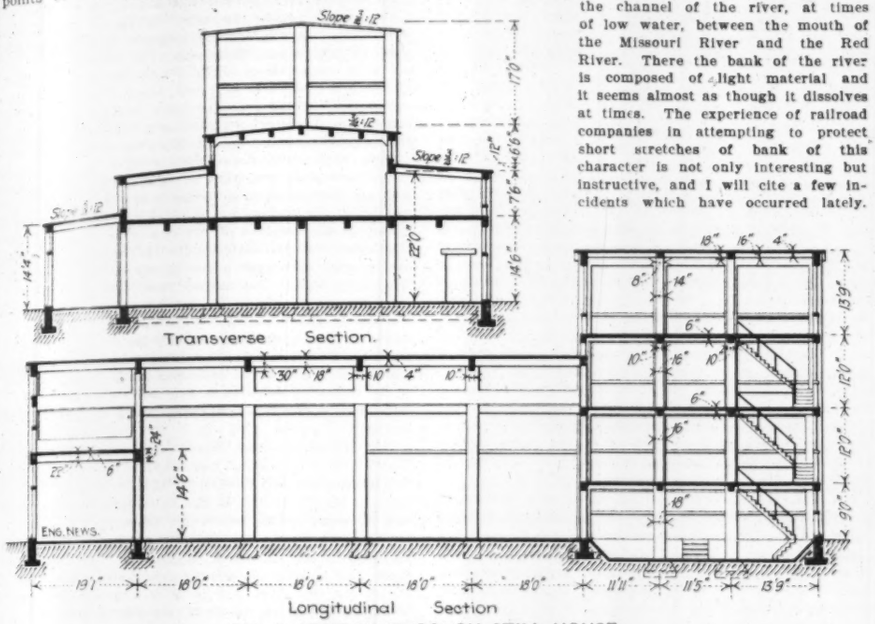


FIG. 5. SECTION THROUGH STILL HOUSE.

The old Iron Mountain route maintained a transfer between Birds Point and Cairo until about the latter part of this summer, but the river suddenly took a turn at cutting into the banks at Birds Point, and in less than 30 days the piling sustaining part of the track was out in the middle of the river and the steamboats were running between that piling and the bank to which it was formerly attached.

At a point about 20 miles above the mouth of the Arkansas River, where a railroad had built a very expensive bridge, and placed the pier supporting one end of the draw some distance back from the water, and sunk this pier to a depth of 50 ft. below the bottom of the river, the bank commenced to cut away about a month ago and when I went past there two weeks ago that pier had disappeared altogether, and there was not even a ripple in the water to show where it had stood.

At Pine Bluff, Arkansas, the Government attempted to prevent the washing of the bank immediately next to the valuable business part of the city, and it seemed as if the attempt was successful, as the bank held for many years. During the flood occurring there last month, the bank on the opposite side of the river commenced to cut, throwing the current at a different angle, and in a very short time the protection was washed from its place, a valuable warehouse fell into the river, and the bank washed within a few feet of a hotel said to be worth $150,000, and a very valuable court-house, both of which are said to be doomed to destruction.

(3) The tributaries of the Mississippi which are valuable for the purposes of navigation are the Red, Arkansas, White, Yazoo, St. Francis, Ohio and its tributaries, Missouri, Illinois, Wisconsin, Chippewa, St. Croix and Minnesota rivers. The Ohio is the only one of these that has any considerable steamboat business on it at the present time. It stands in a class by itself and it is not intended that anything said in this report shall refer in any manner to it, when speaking of tributaries.

The amount of traffic which can reasonably be expected to be carried on these tributaries during seasons of low water, is not, in my opinion, large enough to be commensurate with the cost of preparing them for low water navigation. Many of them if improved at all can only be improved by locks and dams or what is called canalization, which is a very expensive method of improvement, not only in cost of construction, but also in maintenance and operation. On others, practically the same difficulties as set forth in regard to the lower Mississippi would be met with. If the method of operation hereinafter advised is ever put into practice, an enormous amount of low class freight can be transported over these rivers during the seasons of high water, without any improvement on them whatever.

I may as well say here that the river, in my opinion, is not suitable for the transportation of any other than low-class freights, such as coal, lumber, and salt, except grain on the main river. These low-class products can be transported over these rivers at times of high water and stored for future consumption, just as they now are over the Great Lakes during the summer season.

In considering the value of these tributaries for the purpose of navigation, I desire to emphasize the suggestion that there is no economy of transportation, where the interest on the cost of the improvement, together with the cost of maintenance and the actual cost of transportation by water, is greater than the cost of transportation by rail.

It is no answer to this assertion to say that the competition betwen rail and water routes will lower the rail rates. The day of competition is past. Every railroad is entitled to a rate that will pay a reasonable profit, and every dollar of profit taken from a railroad by water transportation must necessarily be added to the tonnage actually carried by it, and it follows that every ton of freight that is carried by water transportation at a cost exceeding that of transportation by rail is a loss to the public. I desire also to emphasize the suggestion that the cost of the items of interest on the

FIG. 6. METHOD OF REINFORCING SLAB AROUND OPENINGS.

cost of improvement and the maintenance of improvement can only reasonably be added to the tonnage carried by reason of the improvement, and not to the tonnage carried through the season of high water, and it is not entirely certain that even on a river like the Ohio the increased tonnage derived from canalization would warrant the cost.

Probably the best canalized river in the world is the Seine River, which has a minimum depth from Paris to the sea of 10 ft., and yet compared with the open rivers of Germany, it has but a small amount of traffic on it. It has only one line of sea-going vessels on it and that line operates but four small freighters. The passenger traffic on that river can be well illustrated by the fact that I was compelled to pay $20 passage money on one of those little freighters from Paris to Rouen, a distance of 150 miles, and the journey occupied 2½ days of daylight.

The Moldau is the only canalized river that I saw either in Germany or Austria, and the traffic on it is comparatively nothing. It required a little more than one day of daylight to make the journey from Melnik to Prague, a distance of about 36 miles, with one of the best tugs I have ever seen, of 250 HP., towing one barge with 200 tons of freight on it and one empty barge. This river had evidently had an immense amount of money spent on it in an attempt to improve it by means of revetment of banks and the building of wing dams, but that attempt must have been a failure, and the only course left to obtain a navigable stream was by canalization.

The Germans seem to prefer an open river with not more than 3½ ft. of water in it to a canalized river, as both the Elbe and the Rhine get below that mark during the season of low water.

Taking the whole study of the question of improvements of rivers, there is much in it that is well calculated to raise very grave doubts as to the value of such improvements. My observation leads me to believe that the improvements placed in the Mississippi River between St. Paul and Rock Island have been more beneficial, comparatively, than any others on any river I have ever seen. It is certain that they have placed the extreme upper part of the navigable portion of the river practically on a par with that part of the lower river which ends at deep water. Whether a still further contraction of that part of the channel from St. Paul to Rock Island sufficient to produce a depth of 6 ft. over the bars, would be an improvement or not, is mere conjecture. I feel quite certain that if such channel were created, it would be practically unnavigable for boats of the present type carrying any considerable tonnage, as I believe it would be practically impossible to make the crossing necessary. At the same time, it seems to me entirely unnecessary to make such an experiment, for the reason that the river is capable of carrying just as much freight, and just as economically, in its present condition as it would if so improved.

Theoretically, a cross-section of river is capable of carrying just a given amount of weight. That is to say, a channel 60 ft. wide and 4 ft. deep, would carry practically the same weight that a channel 40 ft. wide and 6 ft. deep would.

Practical rivermen all tell me, however, that a craft 60 ft. wide and 4 ft. deep, would steer and handle very much easier than a craft 40 ft. wide and 6 ft. deep, carrying the same load, would handle, and would tow just as easily. This is one of the very important questions that ought to be determined by actual experiments under the guidance of practical rivermen, before it is finally determined what future course the Government should take in regard to its inland waters.

I feel confident that if a series of experiments were to be made on our river, it would be found that when a depth of 4 ft. over the bars has been provided for, the river will be as narrow as it ought to be for practical purposes.

One of the popular notions in regard to the use of the river is that if a 14 ft. channel was created from Chicago to the Mississippi River, that a sea-going vessel drawing 14 ft. of water, could go down the Mississippi to the sea at any time when there was more than 14 ft. over the bars, but I am of the opinion that if a craft of that character attempted any such feat when there was 20 ft. over the bars, using only her own steam, she would be stranded on a sand bar before she had made the first crossing. On the other hand, if suitable steering apparatus was provided for her for river navigation, that apparatus would be pounded off in the first storm she encountered, in the open sea.

In addition to what I have said on the question of improvement of rivers, I would like to say that in my opinion the Mississippi River taken as a whole from St. Paul to New Orleans is in the best condition now, for the purpose of navigation, of any river in the civilized world. I would like also to say that the traffic which this river ought to bear, is at the present time greater than the traffic on any other river in the civilized world. And further that the Mississippi River is now in its present condition entirely capable of carrying all the traffic there is in the Mississippi Valley at very economical rates if the methods used by the Germans were put in operation on this river.

Methods of Operation.

(4) If there is any steamboat on the Mississippi River or any of its tributaries that can handle heavy freight up the river as cheaply as an American railroad can, I have never seen it. The "Sprague" is the largest and most powerful steamboat in the Mississippi Valley, and probably in the United States. Her efforts are confined to guiding large fleets of coal boats and barges down the river, and towing the empties back again. Her owners have a large fleet of smaller boats engaged in the same business, and it seems as if the "Sprague" would be duplicated, if there were any great economy in her operation. Her great feats in transportation have been widely heralded as being the acme of success in river transportation by the advocates of river improvement.

If these men are asked why other boats like the "Sprague" are not built, they say that there will be, when the river is improved to such an extent that she can be operated all the season around, which is in effect a statement that she cannot be operated successfully unless the river is improved to meet her requirements. It is also in effect an argument that the river should be so improved as to be made suitable for a certain kind of craft, instead of a type of craft being built which is suitable to the river. There is quite as much difficulty in the operation of a craft of the style of the "Sprague," found in the narrow channel of the river, as from the shallowness of the water. The "Sprague" is capable of taking a fleet of 60 barges of coal down the river in times of high water, but it is very doubtful whether she could take 6 barges from Cairo to St. Louis with a stage of 10 ft. over the bars. The difficulty would lie not in the power necessary for propelling it, but in the ability to guide the fleet into the channel over the narrow crossings.

The only place on the river where any towing of heavily loaded barges in the river is done is between Cairo and St. Louis, where steamers of the class of the "Harry Brown" and the "John A. Woods" tow loads of about 3,500 tons of coal, and the fact that there is so little of it done is a strong indication of the probability that it cannot be done economically.

If either of these boats in taking their tow up the river find their tow swinging toward the bank, when they get as close to the bank as the width of the entire channel in time of low water they commence backing in order to prevent going into the bank. I am firmly convinced that if a channel 14 ft. deep over the bars were ever made it would be utterly impossible for any vessel to handle a tow up against the current in it, of sufficient tonnage to cut any figure as a factor in transportation, if the present method of towing is practiced, largely for the reason that there would be no room in the channel to handle craft drawing anything like that amount of water. Going down stream is a very different proposition for there you can head the craft in its proper position and the current will take it along without danger. But unless towboats that have their loads in front of them have plenty of room to operate going up river it is impossible for them to keep off the bars.

The fact that steamboats now operating on the river find the channel so narrow that they flank the bends, going down river without any tow, shows conclusively that it would be impossible for them to tow any considerable load through those narrow places if the load was ahead of the vessel as is usual in our method of towing. On the extreme upper river the channel is so narrow now in some places that it is almost impossible for a 160-ft. stern wheel steamer to turn around if a strong up-stream wind is blowing. In addition to the difficulty of keeping in these narrow channels, comes the danger arising from crossings where the vessel must go almost straight across the river in order to keep in the channel. Stern wheel vessels making these crossings without any tow to handle sometimes get to swinging in such manner that they turn clear around before the crossing can be made.

On the lower river at Profit Island a sand and gravel company dredge their sand and gravel from the bottom of the river into barges, take it across the river, hoist it into cars and send it down the river about 100 miles by rail, which is some indication that it can be done that way more cheaply than by towing it down river and towing the empty barges back. This is not on account of lack of water, because there is probably not less than 30 ft. over any of the bars between those two points.

I think that it probably is true that heavy freights cannot be shipped down the river as cheaply as by rail, unless they are shipped in very large quantities. It takes practically the same number of men to run a small vessel as it does to run a large one, and as the fuel consumption is comparatively low in down-river traffic, the item of wages is the most important thing in that kind of traffic.

In the carrying of light and bulky freights, steamboats furnish a very much more economical method of transportation than railroads for the reason that they have so much more room for storage. The amount of tonnage of this class of freight is small, and is handled in such small quantities that the railroads are more convenient for carrying it than the boats.

The experience of the steamboat companies operating on the Ohio and lower Mississippi during the last season have been of such an unfortunate character as to clearly indicate that the general freight and passenger business is not a profitable one. The large company doing business of that kind between Pittsburg and Cincinnati, went into the hands of a receiver, and also did the company doing business between Louisville and Evansville. So also did the company doing business between Memphis and Vicksburg. The company operating the large mail vessels between Louisville and Cincinnati gives little evidence of being engaged in a profitable enterprise, and most of the other craft operating on the river have a neglected appearance, which also is a want of business sufficient to constitute them money makers.

These receiverships were not brought about by reason of the extremely low stage of water during the last season, as they all occurred prior to the commencement of the low stage.

Part of the troubles of the steamboat men arise from the lack of proper facilities for the handling of freight, and another powerful factor is found in the uncertain labor conditions. Neither of these things can ever be fully remedied, while the present system is in vogue. The rise and fall of the river south of the mouth of the Missouri is so great that the expense of providing proper facilities for storing and handling freight in an economical manner will be so enormous as to keep capital out of it unless some method can be devised by which a monopoly of the whole business along the river can be obtained.

The difficulties from this source above the Missouri River will be comparatively slight for the reason that the banks there are substantial and the rise and fall will not average more than 15 ft., as compared with an average of about 40 ft. below the Missouri. The facilities for handling freight economically are imperatively needed on account of the labor conditions. The only deck hand that is good for anything is the colored man, and his wages run from $20 to $120 a month, just as he feels disposed or not to work. On the lower river at the present time no steamboat man knows whether he will have a crew of roustabouts or not, when his vessel is ready to start, nor what wages he will have to pay them. He may have to lay in port two or three days for a crew, and then pay $20 or $25 dollars a month more than he paid on the last trip. The uncertainty of the wage question is a very serious factor for the reason that by far the largest item of expense of some of the river craft is in the wages of the deck hands.

Taken as a whole our system of operating the rivers may be classed as a total failure except in the one instance of towing heavy freights down stream. But the fault lies not in the lack of water or depth of channel, but in the system of operation which is in use.

(5) If there is a canal anywhere on which the pro rata cost per ton mile on all tonnage carried over it would not be greater than the amount it would cost an American railway to carry it, if 4% interest on the cost of construction and the cost of operating and maintaining the canal were distributed over its tonnage, I would like to know where it is, so that I could visit it and see how it is done.

Please notice that this does not include the cost of operating the craft which carries the freight but merely the canal toll. There is only one canal in the United States that has very much value for transportation purposes, and that is the one at the Soo. Too much praise cannot be given this important enterprise. In my opinion it is the most valuable asset that the federal government has to show for all the money it has expended on rivers and harbors. Its value lies entirely, however, in the fact that it is a short canal connecting long stretches of water on either side. From a standpoint of aiding in economical transportation it seems to be the extreme limit of success.

Let me call your attention to the other limit. The Hennepin Canal extends from near Hennepin on the Illinois River to Rock Island on the Mississippi River. On a trip I made over it recently I did not see a single vessel in operation on it, doing any kind of freight business, although it has been open for business for several months. It is a beautiful canal, with a good 7 ft. channel, with good locks, and as competent a corps of lock tenders as I have ever seen, but there is no indication at present of any use being made of it. I asked one of the lock tenders if any coal was shipped over it. He said he had never seen any, but added apologetically that he had only been there about six weeks! This in face of the fact that coal can be put on barges at Marquette, a few miles from the mouth of the canal for 85 cts. a ton. That must be the extreme limit of lack of success.

The Manchester Canal in England is probably the best canal for what might be called local transportation purposes in the world. I visited that about a year ago. The General Superintendent of the company showed me every courtesy in viewing their extensive docks and wharfs,

and procured transportation for me on a large vessel over the canal. He also gave me all the literature they had in regard to the canal, including their report for the months up to [illegible], 1907. I also had some correspondence with him since then, and from it all I gather that the company has never been able to pay the interest on its indebtedness.

The canal rates are charged according to the commodity transported, and run from about one-third of a cent per ton-mile to about five cents per ton-mile. These charges do not include dock or warehouse charges.

While it is undoubtedly true that for certain reasons this canal has been of great benefit to the city of Manchester, it does not stand out as a shining example of cheap transportation. I also visited many other canals in England, Scotland and Ireland, and none of them are worthy of mention except perhaps the Caledonian Canal in Scotland. It, however, will only accommodate vessels of about 1,100 tons burden, and traffic on it is very light indeed. There is a beautiful canal in France, extending from Paris to the Saone River near Lyons, but the traffic on it is practically nothing at all, and I am inclined to believe that the end next the Saone is not used at all. I spent one day at Kiel in Germany visiting the Kiel Canal, but only saw one vessel come out of it in all day. That was a warship. I was told, however, that a considerable traffic was carried on at the other end of the canal.

These things are interesting in view of the fact that the engineers who reported on the feasibility of the 14-ft. channel from Chicago to St. Louis reported that the only method of constructing such a channel from the mouth of the Missouri to St. Louis is by canal. If a canal is necessary on that part of the river, and a 14-ft. channel is to be constructed from St. Louis to deep water, a canal will be just as necessary between these points, a distance of about one thousand miles by river, as from the mouth of the Missouri to St. Louis.

A 14-ft. canal is neither fish nor flesh. It is suitable for neither river or sea-going vessels. If freight is transported on it, it will be as necessary to reship that freight as if it had been transported by a light draft vessel.

It will not be suitable for carrying on the business that comes out of the Mississippi River, above the mouth of the Missouri, nor for any of the craft that comes out of any other tributary of the Mississippi, and freight coming out of the rivers will have to be transferred to other vessels when it reaches the canal, causing both delay and expense.

The great coal-carrying companies would not, and could not, use it economically in time of high water, and no other river craft would use it at times when there was sufficient water in the river for their purposes.

The maintenance and operation of such a canal would be very expensive, and when it is considered that its only benefits will be derived by its use in the short season of low water, it seems to me to be utterly impractical.

(6) Within the last ten years the methods of operation of rivers have been so improved in Germany and Austria as to afford what seems to be a very economical method of transportation. Large sidewheel tow-boats carrying no freight whatever themselves, but towing large freight barges behind them, have increased to a wonderful extent. On the Rhine and the Elbe it is difficult to get out of sight of a fleet of barges, even in seasons of low water, when there is not more than 3½ ft. in the channel. Some of these tow boats are very powerful and I was told that some of them would tow fleets containing 10,000 tons up the river against a very considerable current. Their construction is such that very little expense is incurred in the way of maintenance, and their fuel consumption is comparatively very light.

The City of Mannheim, which stands at the head of low water navigation, claims to be the largest distributing center in Germany, and although there is a railroad on each side of the river I was told that practically everything that was distributed from there went either in or out of there by way of the river. In addition to that city there are many other large cities on the Rhine, each of which furnishes a tremendous traffic for the river. A part of it is easy of operation, but there are many miles of it where it is narrow, swift, rocky and dangerous. On the whole it is equally as difficult to navigate as the Mississippi except that the crossings are not so short. There is one place where the channel is so narrow and the current so rapid that horses are frequently hitched to the bow of the boat to assist it through the rapids and to keep it from turning around in the stream.

There are about 30 miles of it that is so dangerous that three different special pilots are used by a vessel in going over that part of the stream, and yet the traffic over that part of the river is simply enormous. Over this part of the river motor boats were formerly used which propelled themselves by picking up a large steel cable that was laid on the bed of the river and pulling themselves up the river by means of large wheels on which clutches were so arranged as to grasp the cable and pull the motor boat along under the cable as these wheels were turned by the engines in the boat. These motor boats were a very economical means of propulsion of the barges which trailed behind them, and it is claimed that one of them could take a given amount of tonnage up the river with one-fourth of the power that is required by the ordinary side-wheel towboat.

The use of these boats was discontinued, however, because of the enormous increase in traffic. Neither towboats or barges are moored to the bank there, unless they are at a dock, but are always anchored out in the stream, and the switching of the cable, as the motor boats came around the bends would pull up anchors and set craft adrift, causing such enormous damage that the company operating these boats was compelled to give up their use. I was told that the great increase in the number of barges anchored in the stream brought about such frequent losses that the company was bankrupted.

A somewhat similar method is in use on the Elbe River where a heavy chain is laid loosely in the bed of the river for a distance of about 290 miles. This chain is picked up and run loosely around two large drums, which being turned by the engines in the boat draw the motor boat under the chain and up the river, the chain falling loosely in the river at the stern of the boat. This method has some of the same disadvantages attending the use of the wire cable, but a more serious disadvantage lies in the fact that the bending of the chain as it moves under severe strain around the drums wears it very rapidly and weakens it to such extent that it breaks frequently causing great delays. This method was in use formerly on a part of the Danube, but has been given up. Both on the Elbe and on the Danube, the claim is made that only about one-fourth of the power is needed by these chain boats to accomplish the results that the ordinary tow boat accomplishes.

I am firmly convinced that some modification of these methods can be used on the Mississippi River between St. Louis and St. Paul, furnishing a remarkably cheap method of propulsion, and have little doubt that a single steel rail can be secured in the channel of the river in such manner as to provide the means for this kind of propulsion and at the same time guide the craft exactly to the spot where it should run, just as a locomotive follows the rails.

The enormous advantage of such a system as this, if it is practical, can hardly be estimated. The German method of towing astern, is the method which should be adopted on the upper Mississippi if the chain system cannot be used.

There is no telling what is the best method of handling for the Mississippi River, except by actual trial. We cannot reasonably expect that private individuals or corporations will make the experiments necessary to determine what method of handling may be suitable for this river as there will be large losses incurred while making the experiments and the person incurring the same would have no monopoly of the method after he had worked the problem out.

The great benefit to be derived by the State of Wisconsin from cheap river transportation ought to impel us to urge upon the Federal Government the necessity of making such experiments as will prove whether or not cheap transportation by water can be procured.

At the present time, a large and enthusiastic body of energetic and patriotic men are earnestly seeking to convince Congress that a deep water channel from Chicago by way of St. Louis to the gulf is the thing most needed by the people of the Mississippi Valley. Fourteen feet through the valley is their slogan. I would like it very much if I could convince myself that such an enterprise is the proper one to engage in, as it would be very pleasant to travel in their company. Besides that, the indications are strong that they will be successful in getting the project started, and it is always pleasant to be one of the successful.

If we take into consideration the fact that their project is simply carrying on further the old idea of deepening channels and building canals, and also take into consideration what has been accomplished in that line by the expenditure of about two hundred and fifteen million dollars on the Mississippi and its tributaries, it compels the thought that we ought to take time to demonstrate the value of the enterprise before entering on it.

Let us grant for the sake of argument the fact that the building of such a channel can be successfully completed; what is there to prove that it can be operated in an economical manner as compared with the operation of an open river in the condition that it now is, always taking into consideration that the interest on the expense incurred by reason of the improvements, and the cost of maintaining and operating the improvements, must be borne by the traffic carried by reason of the improvements.

If there is any place in the world where vessels drawing 14 ft. of water are operated economically in the narrow and tortuous channels of a river, I am unaware of that place. That brings us back, however, to a discussion of the question of the means to be used in economically transporting freight over rivers.

During the closing days of the last session of Congress, Mr. Burton, Chairman of the Committee on Rivers and Harbors in the House of Representatives, introduced a bill providing for the Government operation of rivers, and it promptly passed the House. A similar bill was presented in the Senate and passed the Senate, but with a detail modified in such manner as to prevent the bill becoming a law. Although I am strongly prejudiced against Government ownership of anything that can be operated by private capital, I am very strongly in favor of this bill.

I do not see how we can reasonably expect to enlist the aid of the men of large means in this enterprise. Not only has the passenger traffic, but the movement of freight, been developed along the lines of travel moving eastward and westward. Every ton of freight diverted from that line and carried northward and southward over the river will mean a loss of so much profit to these men who would have to be asked to finance this enterprise, if put through by private means. Human flesh and blood cannot reasonably be expected to make the sacrifice such men would be compelled to make if the enterprise is successful. Not only would the railroads be the losers, but the great grain shipping ports would be likely to lose their prestige and profit.

Another reason for the Government taking hold of it is that the whole river and all its tributaries should be operated as one trunk line, the tributaries furnishing the feeders. A standard craft could be maintained that could be sent to any part of the system as readily as a box car can be transferred from one road to another.

In my judgment a standard 2,000-ton barge drawing not more than 4 ft. of water and carrying a train load of freight, can be operated over any part of the Mississippi River from New Orleans to St. Paul with as great economy and efficiency as any larger craft could be made to do. Such a craft could be sent over the Wisconsin, Chippewa and St. Croix rivers, and probably over the Black River during the proper season in such manner as to procure the highest efficiency. These barges should be constructed of steel and should be divided into such compartments as would minimize the risk of navigation, and should also be fitted with the most modern mechanical devices for loading and unloading. They should be propelled by such power boats as would produce the greatest economy of operation, which would probably be at the rate of about 60 miles a day.

I make this statement from the fact that on one occasion I traveled from Hamburg to Dresden on a tow boat of 550 HP., carrying a crew of ten men, and towing 2,270 tons of freight in nine small barges, at a rate of about 2½ miles an hour against a moderate current, and it was considered a very satisfactory performance.

There is every reason to believe that coal can be transported in cheaply constructed barges in amounts suitable for a certain locality, and the barges left at the point where the coal is to be used during the entire season of its use, thus affording a cheap warehouse for storing the coal while waiting for use.

The enormous amount of capital required to finance this proposition is probably not well understood by the public, nor is the tremendous amount of labor required for organizing it. Ten thousand barges of the kind I have spoken of would be a small equipment for the river and its tributaries. The Rhine alone, which is not much more than half the length of the Ohio, has over 7,000 barges, large and small upon it. These 10,000 barges would require at least 5,000 motor boats. If the barges could be built for $20,000 apiece, and they cannot at the present prices of steel and labor, and the motor boats cost $60,000 apiece, it would require five hundred million dollars to furnish that equipment.

If a ship yard could be found that could turn out one of these barges every working day of the year, and there is no ship yard in the world that I know of that is prepared to do that, it would take 30 years to furnish those barges. It would take many years of experiment to determine the character of terminal facilities which would be most suitable for the purposes and would also require many years to get together an office force which would properly handle the business.

If the expenditure of the 14-ft. channel through the valley should amount to half a billion dollars, that would not in any way lessen the amount that was needed for installing and equipping the river to carry on the traffic that it is expected to carry. Under the present prices, it is entirely likely that not less than one billion dollars will be necessary to provide sufficient equipment to carry the traffic which would be eagerly forced upon the river if such economical transportation can be had thereon as is expected to be the outcome. The magnitude of this traffic can hardly be understood. There is not a bushel of wheat that is raised in the Mississippi Valley west of the river which ought not to find its way to the seaboard by means of that river. There is scarcely a bushel of corn that is exported from the United States that ought not to be taken from the great corn-growing states of the valley directly to the seaboard by the same route, while the enormous quantities of coal used by the enterprising cities on the banks of this river ought to be, every ton of it, transported by means of the river to those cities.

The Footwalks of the Blackwell's Island Bridge.

By F. W. ABBOTT,* M. Am. Soc. C. E., and J. P. H. PERRY.

The footwalks of the Blackwell's Island Bridge are two in number, each 16 ft. 4 ins. wide on the main spans and 14 ft. 2 ins. wide on the approach, and have a length from the Manhattan Anchor Pier to the Queens Approach Abutment of 6,312.5 ft. Taken together, they constitute nearly 2½ miles of walk of unique design and interesting details, and have made necessary methods of construction, which for work of this character are decidedly novel. The Blackwell's Island Bridge, or—as it is by aldermanic decree hereafter to be known—Queensboro Bridge, spans the East River and the south end of Blackwell's Island, and connects the Boroughs of Manhattan and Queens of the City of New York. The structure is of such magnitude that it is well known to the engineering profession without further description herein. It will be necessary only to state that it is a double-deck cantilever structure, originally designed to carry four elevated tracks, four trolley tracks, one driveway, and two footwalks.† The latter are situated on the upper level at a height above the water of about 160 ft. Their positions with respect to the other travel ways provided on this deck is made clear in Fig. 1, which shows typical sections of the river spans. The two walks consist of about 8,000 reinforced-concrete slabs with a uniform thickness of 2 ins., and dimensions which vary frequently, but in general call for a length equal to one-half of the breadth of the walk, and a width of 42 ins. These slabs are reinforced with deformed bars fabricated to a gridiron shape. The casting, storing, curing, handling, hoisting and setting of all these panels constituted the interesting and, in some respects, unusual features of this job.

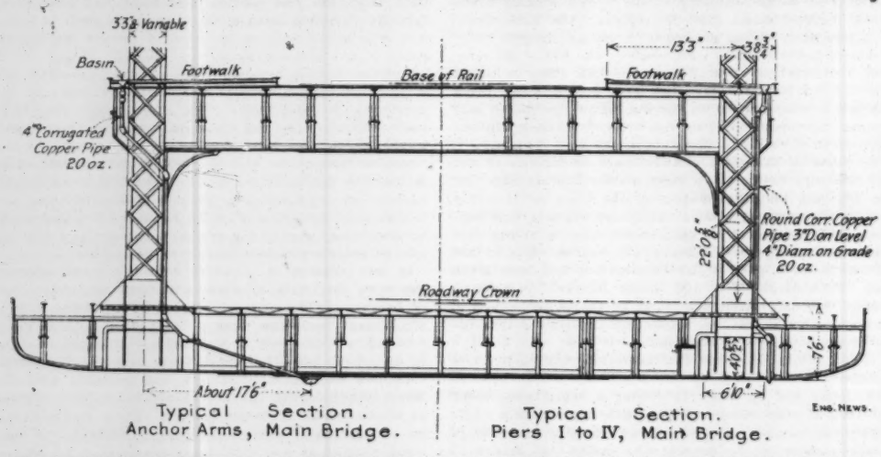


FIG. 1. CROSS-SECTION OF RIVER PORTION OF THE BLACKWELL'S ISLAND BRIDGE, SHOWING THE POSITION OF THE FOOTWALKS.

Before describing the construction methods employed in connection with this work, it will be necessary to outline the detail design of the footwalks and to give some idea of the specifications governing the materials and workmanship.

Design.

The upper deck of the Queensboro Bridge is carried by a series of floor beams spaced 23 ft. to 40 ft. apart, depending upon the location of the main truss panel points. These floor beams are plate-girders about 6 ft. in depth, spanning between the trusses a distance of 60 ft. Connecting these floor beams are eight small girders or stringers 48 ins. deep, spaced in pairs—four of which are to carry elevated tracks and the other four to furnish support for the sidewalk beams and to act as bracing to the floor system. In addition to these eight longitudinal stringers framing into the main floor beams are two others—one on each side of the bridge, which run from bent to bent and are supported by gusset plates projecting from the main truss members. There are thus three longitudinal stringers (Fig. 1) furnishing support for the 7-in. transverse I-beams (generally 3 ft. 6 ins. c. to c), which carry the sidewalk slabs. These 7-in. I-beams are set at slight pitch down towards the outer edge of the bridge by means of raising blocks and plates riveted to flanges of the longitudinal stringers. At either end of the sidewalk beams are 12-in. channels riveted to the I-beam webs. Attached to the top of these channels are 4-in. angles forming an upper flange similar to an I-beam. At the inner edge of the footwalks 4-in. angles run parallel to the channels forming a curbing for the concrete slabs and at the same time are protected by the channel with the broad flange which was just described. At the other boundary of the walks, however, the longitudinal channels have an additional angle connection to add the stiffness necessary to take care of the heavy sidewalk guard railings which are to be placed after the completion of the footwalks. These details are apparent after a study of Figs. 2 and 3.

The reinforced-concrete slabs do not rest directly on the 7-in. I-beams, but, instead, on a 1-in. concrete filler which has beveled edges and a wider top than bottom. Owing to the difficulty of handling slabs 16 ft. long, which would have been necessary had the panels extended the full width of the footwalks, a 2 × 1½ × ¼-in. tee was designed to rest on the 1-in. filler just mentioned, and divide the walk in two parts, each about 8 ft. long. These tees were designed to be supported temporarily on 3 × 3 × 1-in. wood blocks. To provide against any tendency to creep down grade or to move under pedestrian traffic, clips made of 4 × ¼-in. iron were placed over the flange of every sixth I-beam and clinched tight. Details of these clips show in Fig. 3. Where the main truss members run through the footwalks special framing of 6-in. beams was provided.

The details of the reinforced-concrete slabs forming the footwalks are given in Fig. 3. These panels were designed to support the maximum pedestrian traffic which the bridge would ever be called upon to carry, and the plans were worked up along the lines generally followed for reinforced-concrete beams. The reinforcement was calculated for a maximum tensile stress of 16,000 lbs. per sq. in., and the maximum fiber stress allowed for the concrete in compression was 500 lbs. per sq. in., which with spans of 3 ft. 6 ins. (varying down to 2 ft. 2½ ins. and never exceeding 3 ft. 7¾ ins.) and the assumed live load of 150 lbs. per sq. ft. made necess bars, having a net cross section sq. in., spaced not over 6½ ins. addition, longitudinal distributing section of 0.049 sq. in. were sp maximum spacing of 9-in. centers. gridiron generally consisted of bars and five distributing bars. this reinforcement was fixed ½-in. tom of the slab. The slabs thems thick with a nosing 1 in. high, al edge to provide a flush connection curbing provided by the bridge st under side of the slabs have rec bolt heads and for fitting over the tees at the center of the footwalks surface ½-in. thick troweled to finish and then pebble rolled was all parts of these walks. In laying in. open joints were called for, and steel work a ¼-in. fit was required joints were afterwards grouted. Ca basins of general dimensions 12 × 2 ing on tees supported by steel curb connected with corrugated copper pipe provided at every panel. The leaders into gutters on the anchor spans and river on the main spans. Where special around the bridge truss members was the design of the slabs is shown in Fig. 4. Galvanized corrugated sheet iron plates across the I-beams, being cut to fit as closely about the truss members as possible. Other pieces of corrugated iron were bent up about the members, and concrete, reinforced with expanded metal strips, was laid in place and pointed up.

Machine mixed 1:2:4 concrete, with ½-in. broken stone, and cold-twisted rods were used. Perhaps the most vital clause in the whole specifications was that relating to the curing of the concrete slabs. It was stated that the slabs should not be removed from the forms until sufficiently hardened and that then they should be carefully stored under a shed for at least 30 days, during which time they should be kept thoroughly moist. Further, they had to be made in a shed protected from the weather and sun.

Construction.

PLANT.—The curing of the 8,000 slabs constituted the chief problem of this job. To cast about 150 slabs per day, let the forms remain in place long enough to allow safe removal, store the daily output for 30 days and have the oldest slabs available for setting in place, to hoist and set the same number of panels as was daily being turned out in the cast yard; to do all this within the very limited ground area provided by the city and to keep up to the penalty clauses of the contract, required some little study and a very careful arrangement of the plant. The rate of 150 slabs per day was determined as being necessary to finish the job on time and allow for contingencies. It was found in the actual carrying out of the work that such a speed was not only difficult of maintenance, but also was not imperative.

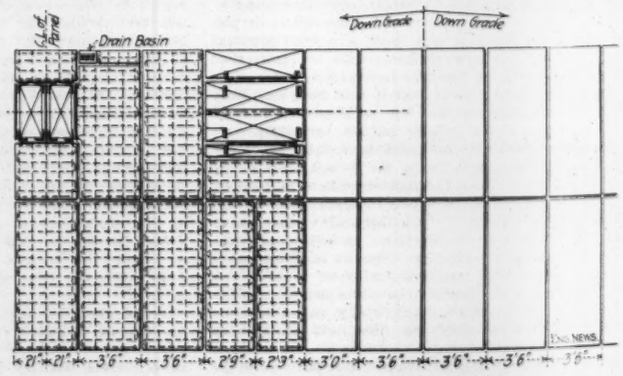


FIG. 2. PLAN OF FOOTWALK FRAMING.

The general lay-out of the contractor's plant shows in Fig. 6 and in Fig. 5, which latter is a photograph taken from one of the main piers

*President, The Abbott-Gamble Co., New York City.
†See Engineering News, Nov. 12 and 19, 1908.

of the b[illegible]ge. The situation of this yard was on the [illegible]ens shore of the river, fronting on Vernon [illegible], Long Island City, where the city permitt[illegible]e contractor to use a space approximately [illegible] ft. long and 200 ft. wide. All materials [illegible] trucked to the job from the Long Island [illegible] terminal of the Long Island R. R., or from [illegible]al dealers. The yard is about at a level with Vernon Ave., so that no difficulty was experienced with delivery to any part of the working ground.

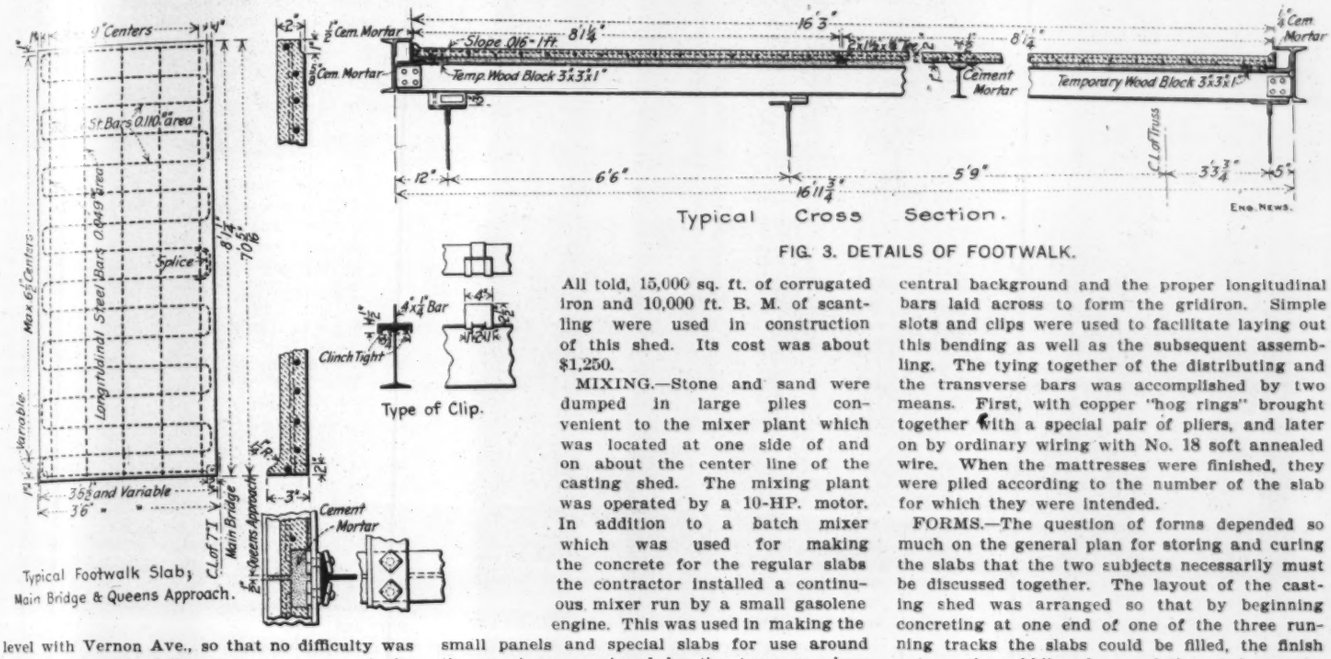


FIG. 3. DETAILS OF FOOTWALK.

For handling the concrete, the steel, and the completed slabs, an extensive system of Koppel industrial tracks was laid out as shown in Figs. 5 and 6. Eight circular turn-tables were necessary to make the operation of this miniature railroad successful. Nine cars consisting of four wheels and a single channel iron body (Fig. 7) were provided. A wooden flooring was made up of four 4 × 4-in. stringers, resting on 2 × 8-in. planks, and bolted to the car body. The stringers were wrapped with bagging to eliminate as much of the jar on the slabs as possible. The rails of the Koppel system are fastened together by steel ties or plates and come in sections about 12 ft. long. The track was laid on 2 × 4-in. stringers supported on 2 × 4-in. posts well braced together.

A large shed was used for the casting and storing and curing of the concrete slabs. In deciding upon the character of the protection for the slabs demanded by the specifications, consideration was given to tents, cheese cloth shields, wood and tar paper roofs, and corrugated iron. Owing to the proximity of the concrete yard to the East River, and its unprotected position with regard to the wind, and owing also to the expensiveness of canvas, tents were quickly eliminated. Cheese cloth shields fell in the same class as tents, and would not have been satisfactory. Corrugated iron was found, upon investigation, to be cheaper than tar paper or wood, and much more substantial, in addition to giving a roofing which could be put up very quickly. The framing for supporting the shed consisted of 4 × 4-in. posts, made of two pieces of 2 × 4-in. stuff nailed together, spaced 8 ft. on centers longitudinally, and 20 ft. transversely. The light trusses spanning between these lines of posts were built up by nailing 2 × 4-in. rough spruce together in the form of a simple truss. The corrugated plates rested on 2 × 4-in. purlins laid from truss to truss. The plates were 8 ft. long, 30 ins. wide and in placing were lapped over each other to prevent leakage. At the post lines or where the roof trusses met, wooden and asphalt paper gutters were built to lead away the water. At the ends and sides of this shed, which was 240 ft. long by 60 ft. wide, with a capacity of 210 slabs of one making, canvas curtains were hung and made so that they could be rolled up out of the workmen's way. These show in the foreground of Fig. 5. For lighting this working shed on dark days and in the event of night work, strings of 16 c. p. incandescent lights were strung in six lines along the length of the shed.

All told, 15,000 sq. ft. of corrugated iron and 10,000 ft. B. M. of scantling were used in construction of this shed. Its cost was about $1,250.

MIXING.—Stone and sand were dumped in large piles convenient to the mixer plant which was located at one side of and on about the center line of the casting shed. The mixing plant was operated by a 10-HP. motor. In addition to a batch mixer which was used for making the concrete for the regular slabs the contractor installed a continuous mixer run by a small gasolene engine. This was used in making the small panels and special slabs for use around the openings occasioned by the truss members passing through the footwalks. Also this continuous mixer was utilized for making the finish mortar. The batch mixer was set on a staging at an elevation permitting discharge of its contents directly into the concrete cars. Materials were wheeled up on to a platform behind which was the cement house. As fast as the concrete was mixed, it was dumped into the concrete cars. The industrial tracks were operated under these heavy cars very satisfactorily. There were no derailments at the turn-tables. The cars were simply Koppel trucks with a rectangular wooden box bolted to the body. In one side of this box an opening with a sliding gate was provided. The car when filled was pushed—two men generally being enough to keep a car moving, after four or sometimes six men had once started it, to the point in the shed where they were casting slabs.

REINFORCEMENT.—The scheme devised for bending, with the accuracy demanded by the small size of the concrete slabs, some 125 tons of ¼-in. and 21/64-in. bars is best made clear by reference to Fig. 8. The laborer in the foreground at the left is holding one of the mattresses or grid-irons which constituted the slab reinforcement. The bent bars were all 21/64-in. square—the ¼-in. bars being used for the transverse rods. A bending table about 5 ft. high was made of two heavy horses built of 2 × 10-in. planks and 4 × 4-in. top pieces. Across these horses were laid 3 × 12-in. boards securely nailed together. At opposite corners of this table, special pipe bending attachments were bolted to the 3-in. planks. At the other diagonal corners the table was extended at a single plank width for a distance of about 15 ft. The bars to be bent into the transverse reinforcement were laid on these long planks. One bar at a time was put through the bending machine. To determine the proper length to be bent up at right angles, a plank was set upright at just the correct distance from the bender. The bar being bent was run through the machine until butted up against this vertical board. These can be seen at the right of Fig. 8. The bending continued with single right angle turns until the bar's entire length had been utilized. The bent up bars were then laid on the frame work shown in the central background and the proper longitudinal bars laid across to form the gridiron. Simple slots and clips were used to facilitate laying out this bending as well as the subsequent assembling. The tying together of the distributing and the transverse bars was accomplished by two means. First, with copper "hog rings" brought together with a special pair of pliers, and later on by ordinary wiring with No. 18 soft annealed wire. When the mattresses were finished, they were piled according to the number of the slab for which they were intended.

FORMS.—The question of forms depended so much on the general plan for storing and curing the slabs that the two subjects necessarily must be discussed together. The layout of the casting shed was arranged so that by beginning concreting at one end of one of the three running tracks the slabs could be filled, the finish put on, the pebbling done and the whole process made continuous, and all operations carried on without interruptions by men engaged in any other work. The form question was studied carefully and finally worked out as follows: For the first set of slabs, light panels of ⅞-in. tongue-and-groove roofing nailed to 2 × 4-in. cleats were made up and laid level on 2 × 4-in. stringers placed on the ground. The thickness of the slab being but 2 ins., the form for holding the concrete in place was very simple in general character, though interesting in its details. After one slab had been made with the panel, just referred to, as a base, a single thickness of paraffine paper was spread over it and given a coat of paraffine oil. On this was then set the same form that had been set on the wooden panel—only with slight modifications. The form used after making the first tier of slabs consisted of four lengths of 2 × 4-in. material, faced with steel plates, dressed on all sides, with cleats nailed in so that with a completed slab to rest the form on, it would offset to one side longitudinally, and also to one side transversely. The amount of the offsets were about 3 ins. The four sides of these forms were held together with two ⅝-in. bolts, one at either end of the slab, working through a slot at the end where the offset was made and working clear at the other end where the onset occurs. (Fig. 7.)

FIG. 4. DETAILS OF FOOTWALK AT DIAGONAL POSTS.

CASTING.—With these forms, which could be set up or removed very inexpensively, and with great rapidity, the work of casting the 8,000 slabs required for the footwalks was carried on after these lines. A tier of slabs were cast on, say, Monday. An average day's run was about 125 slabs. By beginning at one end of the shed, and working straight ahead, it was found pos-

sible the following (or Tuesday) morning, to return to the starting point and lay the paper, which was the only thing separating the successive tiers of slabs, directly on the slabs which had been finished on Monday. The scheme of having the finishing gangs follow directly behind the concrete men made the time of finishing a slab only an hour at most later than when it was concreted. Therefore, returning Tuesday morning to Monday morning's point of beginning gave about 24 hours between a finished slab and the depositing of another slab on top of it. By means of the "offsetting and onsetting slabs" there were no posts required—only a few light wedges to fit between the edge of the lower slab and the bottom of the form.

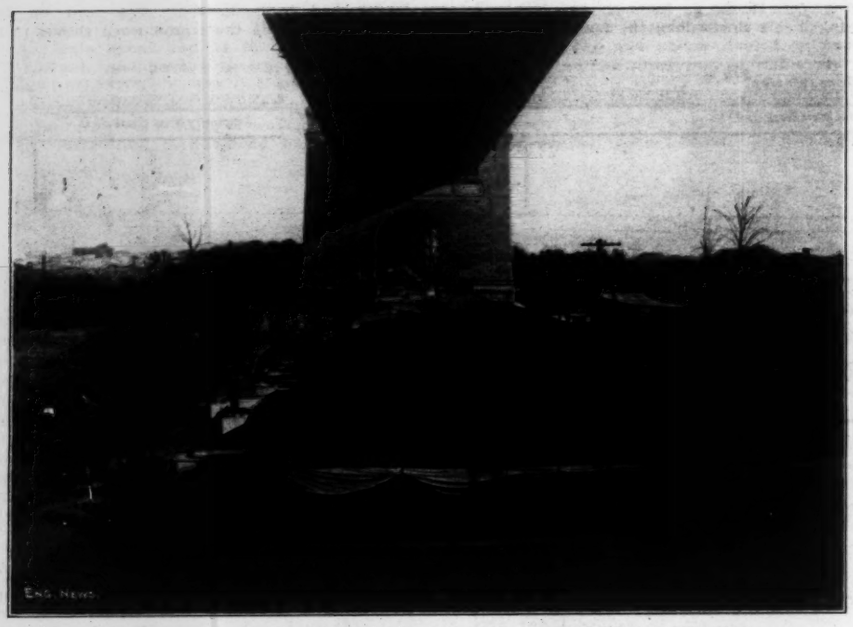


FIG. 5. VIEW OF CASTING SHED FOR FOOT WALKS OF THE BLACKWELL'S ISLAND BRIDGE.

By confining operations to one part of the casting shed for an entire week, and then shifting to the other half of the shed, for the whole of the following week, it was possible to have a series of piles of slabs six high, which would be two weeks old before it was necessary to return to them for space in which to concrete. It was found convenient to handle slabs when they were about 15 days old. Also, in the management of the casting yard it frequently was best to run some of the piles of slabs 18 high, thus using less room for a week's work and enabling greater aging of the slabs before removal to the bridge above. There was no difficulty experienced in placing one slab above the other with only a 24-hour interval. The paper film working perfectly except that considerable difficulty was experienced from the tendency of the paper to stick to the freshly deposited concrete and making removal troublesome. The oil was done away with and a soft soap substituted for painting the paper with. The oil seemed to make the paper impervious to water and add to its tendency to stick to the concrete, and more especially rendering washing the paper from the bottom of the slabs at the end of a few weeks exceedingly arduous. The coating of soap, however, served quite as well to prevent breakage of the paper in laying the concrete, but seemingly rotting the paper soon after application. At any event, it was found very easy to tear off the paper on the bottom of the slab, after the substitution of soap for oil. Frequently the paper would come away itself.

When the forms were set and the paper bottom painted with soap or with oil, the concrete was raked out of the cars. A layer about ½-in. thick was spread evenly over the slab and then the reinforcing mattress was laid thereon. The slab was then concreted to within one-half of the finished depth. Another concrete car containing finish mortar was brought alongside the uncompleted slabs and the finish put on. The masons worked in pairs and troweled the slabs to a good, hard finish. The average speed of two cement masons on this kind of work was 25 slabs per day.

STORAGE.—After the slabs had cured for the required length of time, they were picked up as shown in Fig. 9. Two bents consisting of 2 × 4-in. posts with 2 × 4-in. cross pieces and knee braces of the same material joined with two 4 × 4-in. pieces reinforced with iron strips on their bottom sides constituted a rough gantry supporting a triple block. The contrivance for handling the concrete panels shows in the foreground of Fig. 9. It was composed of three 2 × 4-in. boards running the long way of the slab. Bolted across these were two similar members. Near one end, these transverse pieces were hinged as shown. Bolted to the underside of the two outer longitudinal members of this frame were iron brackets deep enough to allow the slab to rest on their lower flange. By means of hinges and slots, in the ends beyond the hinges, in which long-handled swivel bolts worked to tighten up or release the outer longitudinal boards and permit their sliding either in or out, the pick-up frame could be clamped about a slab. The triple block was connected to an eye-bolt in the center board of the frame and two men easily lifted a slab weighing about 800 lbs. and swung it to a position over the car on which it was to be lowered, strips 2 × 2-in. scantling being placed under each slab to allow the release of the hinged frame work. In the releasing of the pick-up frame, all that was necessary was to loosen up the locknuts near the hinges and pull out the brackets from under the slab.

HOISTING.—The hoist for getting the finished slabs to the upper deck of the bridge was a little out of the ordinary design. The cage itself was of the usual character. It consisted simply of a heavy floor with overhead bracket connecting with the hoisting cables. Instead, however, of having guides of wood in the form of corner or side posts, extending the entire height of the lift, the cage was kept in its course by four ¾-in. wire cables, one at each corner, anchored to dead men in the ground, and drawn taut and made secure to the head frame. Power for this elevator was furnished by a 40-HP. electric motor with hoist. The head frame was built out from the side of the bridge. The main posts were 12 × 12-in. yellow pine. The inner end of the lower horizontal timber was wedged tight under the flange of the lower deck girders, whereas the inner end of the second horizontal member was fastened to a similar bridge girder on the second deck. The sheave blocks were made up of 6 × 12-in. timbers, bolted to the top pieces of the head frame. The hoist was able to deliver cars carrying a load of four slabs to the second deck of the bridge in 20 seconds, after leaving the ground. The cars upon arrival at the landing stage were run out on the tracks provided.

PLACING SLABS.—The length of the walks—very nearly one and a quarter miles—made a tramway system imperative for economical distribution of the slabs. Industrial tracks similar to those used in the casting yard below were purchased and a single track built the whole length of the main bridge. When the slabs on the main bridge had been placed, this track was moved to the Queens approach span, thus economizing in the amount of rails to be purchased. At intervals of about 1,500 ft. a flat plate was set at the level of the top of rail and a short section of track built at right angles to the main line. The flat plate acted as a transfer table for passing track purposes. The tracks on this upper deck of the bridge were supported on cross ties of wood—generally 3 × 6-in. pieces—resting on the top flanges of one pair of longitudinal girders, referred to in the beginning of this article.

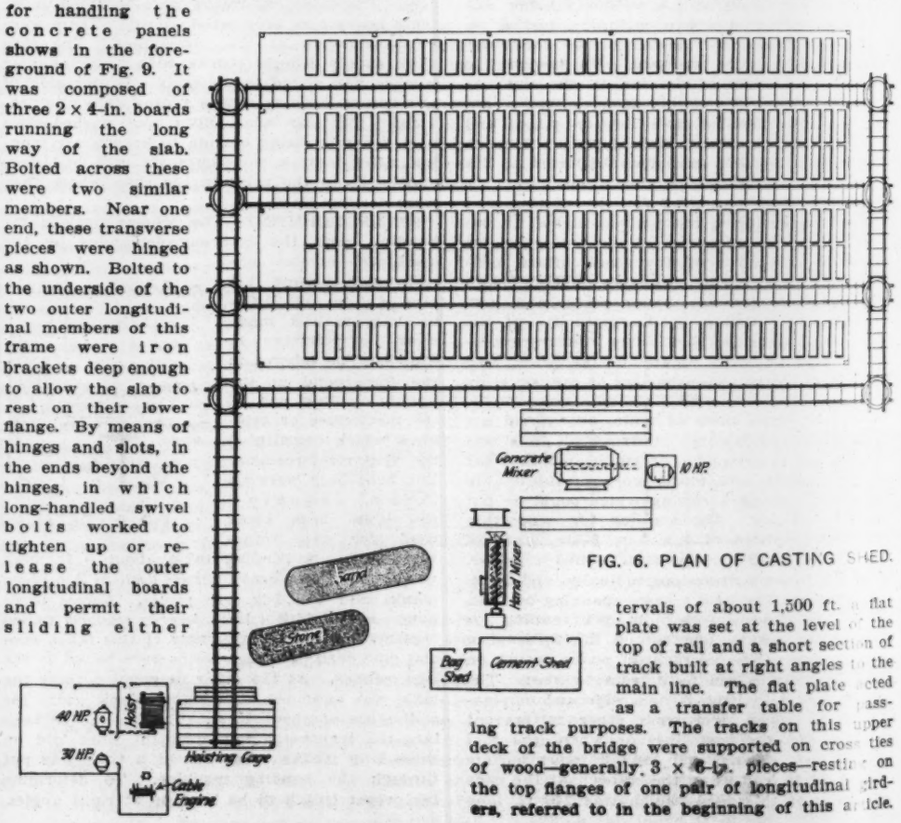


FIG. 6. PLAN OF CASTING SHED.

About every 60 ft. wooden spools were set for the support of the cable, which was of wire ¾-in. diameter. Alongside the track a temporary runway two planks wide was laid. The cable was operated by a 30-HP. motor in the power shanty containing the hoisting machinery. The cable passed up through the main deck of the bridge at the base of the hoist head frame. Passing over a sheave at the second deck level, the cable ran over the bridge to the Manhattan end and returned to the winding drum, after going around a heavily weighted, suspended sheave provided to keep the cable taut. The cars used on this tramway were similar to those in the yard on the ground. The cars bought for this work were designed to operate in trains of two cars each. Therefore, every alternate car was provided with a cable grip and a powerful hand brake. The tramway was laid very simply, and in its operation, aside from rather severe wearing of the guide spools, gave complete satisfaction.

FIG. 7. VIEW IN THE INTERIOR OF THE FOOTWALK CASTING SHED, BLACKWELL'S ISLAND BRIDGE.

The tramway being on but one side of the bridge, it was necessary to provide travelers for distributing the concrete slabs to the footwalks on either side of the structure. There were three of these built, two for the main bridge and one for the Queens approach. Fig. 10 shows the two built for the main spans, one in the foreground, the other in the distance. The exceptionally satisfactory manner in which these travelers have performed their duties merits detailed description of them. In the first place, advantage was taken of the channel iron guard forming the inner boundary of the footwalks as providing excellent running tracks. The detail connections between the 8-in. cast iron flanged wheels and the main supporting bents can best be seen at the right end of the traveler in foreground. A pair of 3-in. channels with journal blocks for the wheel axles bolted to the top flanges, support a pair of 4-in. channels which in turn carry the pair of light latticed trusses spanning between the wheel bents. These trusses, which were cradled and much nearer together at the top than at the bottom, were made up of 1 × 2 × ⅛-in. angles and of 3 × 1-in. channels riveted together and latticed with ¼ × 2-in. flat bars. The top chords of the trusses were connected at each panel joint by 2-in. angles which supported a 5-in. I-beam. This I-beam acted as a running rail for the differential pulleys, and was extended out beyond the main part of the traveler a distance on each end of 8 ft. Hanging from the traveler proper, by means of ¼ × 2-in. straps fastened to 2 × 6-in. planks, was a light wooden platform or bridge for men to walk on when pushing the triple block with its slab burden across from the tramway to the footwalk at the other side of the bridge.

Perhaps the most difficult part of the traveler to perfect was the grab frame for picking up the slab and more especially for setting it in final position without cracking it. After considerable experimenting, the device shown in Fig. 10 was contrived, and found to work well. Each traveler was provided with two of these grab frames, which were operated by means of differential pulleys. The frames consisted of three U-shaped iron strips made of ½ × 3-in. flat sections, bolted to two 2 × 6-in. boards. As a tram car with a load of slabs came under the traveler, one of the grab frames was pushed in position so that the iron hooks could be slid under a slab. The pulley block was fastened to the frame so that when loaded the latter had a slight tilt backward to prevent the slab sliding out. The two grabs were used alternately to carry slabs, first to one footwalk and then to the other. For moving the gantry itself, a sprocket wheel was connected to one flanged wheel of each pair supporting the gantry. A light chain going over these lower sprockets connected to smaller gear wheels, mounted on a 1-in. shaft running the whole length of the traveler. By means of handles, one at either end of this shaft, two men could move the traveler along the bridge with ease. The cost of these travelers set up complete was about $500 each, including the triple blocks.

The concrete slabs after being hoisted in the elevator, run along the bridge on the tramway, and picked up by the grab frames on the travelers, were set in position accurately only after a good deal of trial. To begin with, the temporary wooden blocks shown on the plans were done away with and small concrete blocks substituted. To enable the slabs to be removed from the grab frame, several pieces of 1-in. square bars about 10 ft. long were laid across the tops of the footwalk I-beams. The grab could then be tilted and one edge of the slab rested on these bars and by further lowering and tilting of the grab the slab could be pushed up hard against its neighbor, the concrete blocks put under it on the I-beam flanges and the slab lowered to final position. The 1-in. bars could then be pulled out from under it and moved ahead to receive the next slab. Before the slabs were set the tees were laid across the I-beams. In providing for the filler under the slabs and tees, as shown in Fig. 3, it was found best to spread a layer of stiff mortar along the top of each of the footwalk I-beams. This was made about 1¼ in. thick and was laid just before putting a slab in place. The slab pressed the mortar into a filler of about 1 in. thick and insured a good bond between the I-beam, tee and slab. The joints between the slabs were then filled with a softer mortar and pointed up.

The Queensboro Bridge, for all spans except the center span over Blackwell's Island, runs on sharp grades so that with the tilting of the footwalks towards the outer edge of the bridge, the drainage of water was made certain. On the center span, however, the grade is level, and it was necessary, in addition to the slope of the footwalks, to provide the low points between every bent. This was accomplished by giving a slight pitch to the longitudinal channels which run across the footwalk I-beams. Every alternate joint between these channels was a high point, and every other joint a low point. This frequent grading of the sidewalk made it im-

FIG. 8. BENDING TABLE FOR THE FOOTWALK REINFORCING.

possible to cast the 1-in. nosing, shown on the plans, when the slabs for this portion of the bridge were made. This difficulty was overcome by leaving off the nosing in the casting yard, and inserting in the concrete, at the time of placing, a narrow strip of expanded metal.

FIG. 9. MOVING FINISHED SLABS FROM CASTING SHED.

This was left partly in the concrete and partly out, and was placed just where the nosing would have been. When the slabs were set in position on the bridge, this strip of expanded metal was turned up and stiff mortar put under it and over it, and pointed to the proper slope to make a nosing which would conform to the varying grade at which the slab was set. In this manner the nosing followed the drainage lines and produced the required low point opposite the catch basins.

The placing of small special slabs, which fitted around the bridge truss members, was done largely by hand. The slabs came up from the casting yard and were laid out on the part of the footwalk already placed. They were then shoved and barred into position, being set on small concrete blocks in a manner similar to the big slabs. In many cases, however, the slabs about the truss members had to be cast in place. Hand mixing of the concrete was allowed for this work. Materials were brought up from the ground, and the completed part of the footwalk used for a mixing board. Only very small quantities of concrete were required to be mixed at a time, and no particular difficulty was experienced in cleaning off the completed slabs afterward. The corrugated iron plates called for in the plans were cut to a ¼-in. fit, with the main truss members and small sheets of expanded metal laid on them. The concrete, after being placed, was pointed up and rolled to give a finish equal to the rest of the footwalk.

After the setting of the slabs was well under way, and the job had become organized, it was possible to place and finish about 150 slabs a day. For the pointing up of the 1-in. filler between the footwalk I-beams and the underside of the slabs at the outer edge of the walks a light, movable scaffolding was built on the main deck of the bridge. For the inner half of the walk this pointing was done from light planks laid on the lower flanges of the longitudinal girders. The planks were moved ahead very easily and were reached by means of light ladders. This pointing up followed right along with the placing of the slabs. Men working on these scaffolds could point up the filler very rapidly and at the same time clear off any paraffine paper which might have stuck to the bottom of the slabs. There were comparatively few panels broken in moving, either in the casting yard or in transporting and setting in place. The work presents an excellent appearance and promises to wear well under its future heavy traffic.

The designs for these footwalks were made by the engineers of the Department of Bridges of the City of New York, Mr. J. W. Stevenson, Commissioner, Mr. C. M. Ingersoll, Chief Engineer, Mr. A. L. Bowman, Consulting Engineer, and Mr. J. D. Wilkens, Engineer in Charge of designs for the Queensboro Bridge. The construction work at the bridge was under the supervision of Mr. J. A. Knighton, Resident Engineer, and Mr. E. A. Fintel, Assistant, in charge of the erection of the entire bridge. The Abbot-Gamble Co. was the Contractor.

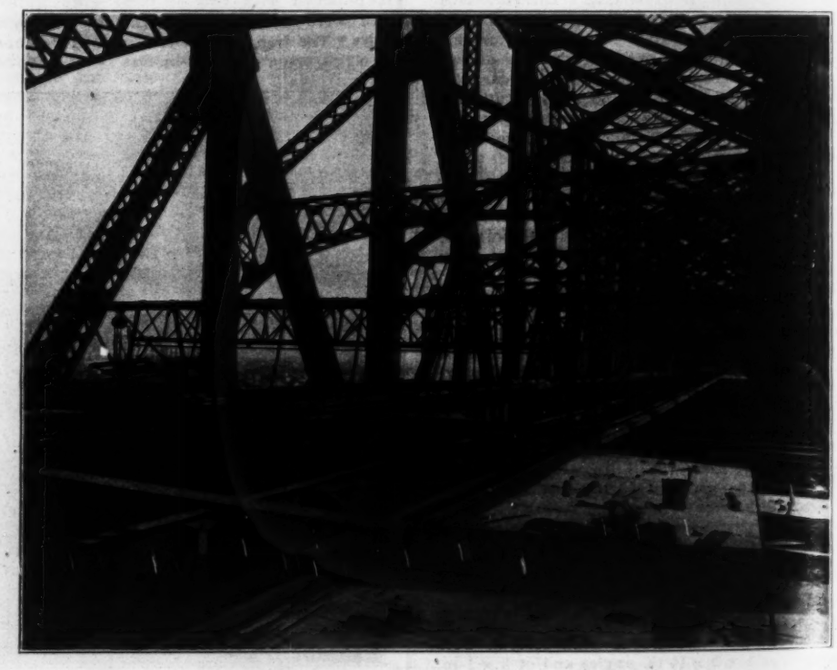


FIG. 10. PLACING THE SLABS ON THE BRIDGE
(View showing erecting railway and gantry.)

Comparative Estimates for Diffe[illegible]nt Types of Bridges for the Same Cro[illegible]ng.

The "Annales des Ponts et Cha[illegible]ées" has recently published a table of cost est[illegible]tes made by M. J. E. Ribera for various style[illegible] bridges to be used in a crossing of the Du[illegible] River in Spain. In investigating the proje[illegible] thirteen different forms were completely studi[illegible]nd their respective costs are noted in the a[illegible]panying table. The hinged steel arch given [illegible] to the last in the table was the type select[illegible]nd it is now in course of construction. It will [illegible] noticed that the suspension bridge is somewh[illegible] cheaper, but the engineer in charge regarded t[illegible] style of bridge as less stable and permanent th[illegible] the one selected.

The crossing is about 625 ft. wide [illegible] the top of two steep banks some 300 ft. a[illegible]ve low water, at which elevation the span is about 90 ft., and some 225 ft. above high wat[illegible], where the span is 300 ft.

TABLE SHOWING COMPARATIVE ESTIMATES ON BRIDGES ACROSS THE DUERO RIVER, SPAIN.

	Masonry of dressed Ashlar.	Masonry Concrete and rubble.
Masonry—Two stories, with central arch of 130 ft.	$345,400	$192,800
Trusses—Three spans, about 165 ft. each:		
On masonry piers	220,200	139,400
On metallic piers	130,400	82,400
Single span:		
330 ft. bowstring	131,000	116,400
400 ft. double intersection	115,000	94,800
Metallic Arches—		
High, with truss approaches, 330 ft. span:		
No hinged, rise to span = 1:3.3	130,800	114,000
Two hinged, rise to span = 1:2.5	127,000	110,200
Two hinged, rise to span = 1:3	122,800	106,400
Flat, rise to span = 1:5. 400 ft span:		
With masonry approaches:		
No hinged	101,000	81,800
Hinged	88,600	70,400
With steel approaches:		
No hinged	69,200	63,400
Hinged	66,600	60,900
Suspension bridge, 420 ft. span	61,400	52,800

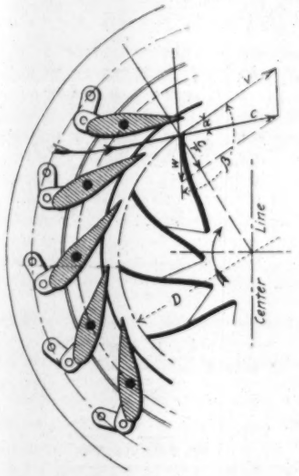
RAILWAY OPERATION BY TELEPHONE is steadily gaining in favor, as is evidenced by the announcement that it has been decided to replace the telegraph system with telephones over the entire main line of the Atchison, Topeka & Santa Fe Ry., from Chicago to the Pacific coast. Notes relating to train despatching by telephone were published in Eng. News July [illegible], 1908, p. 26 and Aug. 6, 1908, p. 148, and reference is made to this system in the report of the Block Signal and Control Board, Eng. News, Jan. 14, 1909, p. 36, middle column.

A Comparison of American High-Speed Runners for Water Turbines.

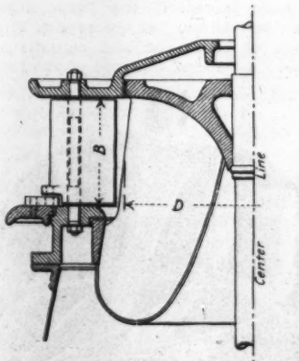
By S. J. ZOWSKI.*

The characteristic tendency toward increase of both speed and capacity of machines represents, in general, a conflict between the requirements of speed and those of capacity. Increased speed would lead to smaller size, while increased capacity calls for larger size. This conflict proves especially difficult to harmonize in the case of low-head water turbines: Due to the low velocity of flow resulting from a small head of water, the diameter of the runner must be relatively small in order that the required working speed may be obtained. Also, in order to get the necessary passage-area for developing reasonable capacity, the height of the runner must be relatively large. If now a further increase of speed is desired, the runner diameter must be reduced still further and the height still further increased. With such runner proportions, obviously, the possibility of obtaining rational passage-areas is very limited, and the design of runners for extreme conditions becomes exceedingly difficult. The efficiency of such runners will always be lower than that of runners of moderate speed and capacity.

The purpose of the following study† is to show how far the American manufacturers of standard low-head water turbines have progressed in the attempt to secure high speed and high capacity simultaneously, and to compare the results which they have obtained in their respective runner types. The data for this study were taken from the catalogs of the different concerns. The values of power and speed tabulated in these catalogs are based on careful tests, made in the Holyoke testing flume, and the values of the discharge are based on the assumption of 80% efficiency—although the actual efficiencies are much higher, from 82 to 85% according to Holyoke tests. Therefore the following study will give practically reliable information. The *comparison*, at least, will be accurate, because if mistakes in the testing of the wheels be made (and some engineers, especially in Europe, believe that the Holyoke tests are not quite reliable) the same mistakes would be made on all runners.



Part Horizontal Section



Half Vertical Section.

Fig. 1. Horizontal and Vertical Sections of High-Speed Turbine.
(Showing relation between velocities and bucket and vane angles.)

*Instructor in Mechanical Engineering, University of Michigan, Ann Arbor, Mich.

†A revised and improved abstract of an article by the writer published in "The Michigan Technic" of June, 1908.

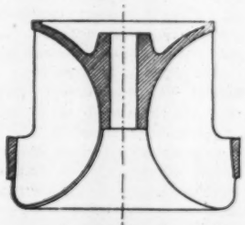


Fig. 3a. Vertical Section.

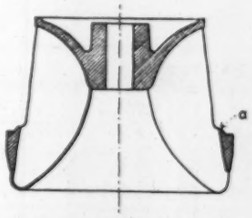


Fig. 4a. Vertical Section.

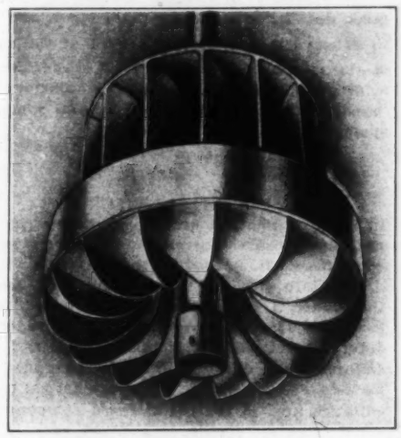


Fig. 3. The "New American" Runner.

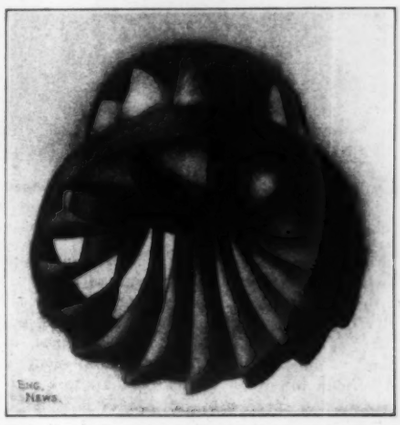


Fig. 4. The "Improved New American" Runner.

FIGS. 3 AND 4. THE "NEW AMERICAN" AND "IMPROVED NEW AMERICAN" RUNNERS.
(Dayton Globe Iron Works Co., Dayton, O.)

NOTATION.—To get a proper basis for this study some of the principal turbine formulas must be recalled and some new ones derived. The following symbols will be used:

$H\text{-}P$ = effective power of the runner.
n = speed of the runner, in revolutions per minute.
Q = discharge of the runner, in cubic feet per second.
H = net head acting upon the turbine = gross head minus all losses in head-race, conduit and tail-race, in feet.
e_h = hydraulic efficiency of the turbine.
$(1 - e_h)\,H$ = head lost inside of turbine itself due to friction, whirls and shocks.
D = mean entrance diameter of runner, in feet.
B = height of guide case, in feet.
a = angle between entrance speed and peripheral speed at D.
β = bucket angle at D.
c = real entrance speed at D.
w = relative entrance speed at D.
v = peripheral speed at D.
c_r = radial entrance speed at D = radial component of c (see Fig. 1).

Criterion of Speed.

All modern American turbines are pressure turbines of the radial inward-flow type. The definition of the pressure turbine (the so-called reaction turbine) is: The water enters the runner and flows through the same under a certain static pressure, as the whole available head is not turned into speed at the entrance; the entrance speed is smaller than the spouting velocity, leaving part of the pressurehead to accelerate the relative water stream in the runner.

The regulation of the hydrodynamic conditions in the runner for a flow either with or without pressurehead is possible by a proper choice of the bucket and guide-vane angles β and a.

If the entrance into the runner is without impact and the discharge is vertical, then,

Real entrance velocity

$$c = \sqrt{e_h\, g\, H}\,\sqrt{\frac{\sin\beta}{\sin(\beta - a)\cos a}} \qquad (1)$$

Peripheral velocity

$$v = \sqrt{e_h\, g\, H}\,\sqrt{\frac{(\sin\beta - a)}{\sin\beta\,\cos a}} \qquad (2)$$

Both c and v are functions of the angles a and β for a given head.

Low-Speed Runner.

Medium-Speed Runner.

High-Speed Runner.

Fig. 2. Diagrammatic Sketches of the Low, Medium and High-Speed Types of Runners.

For $\beta = 90°$ the factor

$$\sqrt{\frac{\sin(\beta - a)}{\sin\beta\cos a}}$$

is equal to unity for all values of a. For all angles $\beta < 90°$ the value of the factor is smaller than 1; for all angles $\beta > 90°$ its value is larger than 1.

As the speed of low-head turbines will, as a rule, be relatively high, all American standard runners for low heads have $\beta > 90°$. We call these runners high-speed runners. Runners with $\beta = 90°$ are called medium-speed runners (sometimes called runners of the German type). Runners with $\beta < 90°$ are called low-speed runners. (See Fig. 2.) The high-speed runners are frequently called the American type.

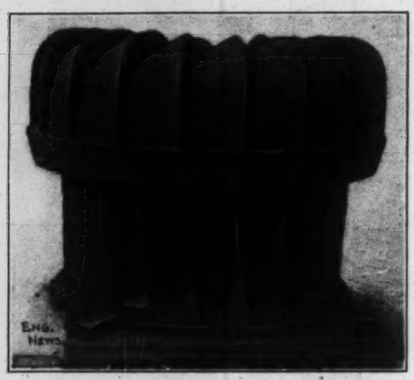


Fig. 5. Victor Type A Turbine, "Increased Capacity" Runner.
(Platt Iron Works Co., Dayton, O.)

Practical reasons, as for instance the necessity of an easy, smooth and not too long curvature of the bucket, limit the increase of β. The value $\beta_{max.} = 135°$ will represent good American practice. Increase of angle a also increases the speed v for all angles $\beta > 90°$ But to avoid what is called "overgating" it will be advisable to not assume too high values for a. Tests show that the capacity of the runner reaches its maximum at a certain gate-opening. To open more is not only useless but wrong, since the efficiency as well as the output goes down. Although by proper design of the runner the point of overgating may be moved upwards, it is not advisable to depend too much on this. Less efficiency than expected does not disappoint the turbine buyer so much as when the turbine is found to give less than the expected maximum power. It is not wise to make a larger than 40°.

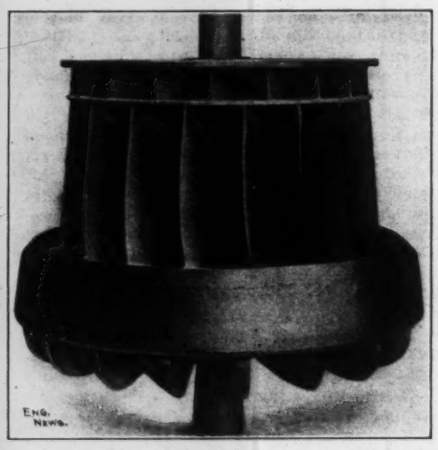


Fig. 6. Runner of "Samson" Turbine.
(James Leffel & Co., Springfield, Ohio.)

The hydraulic efficiency may be taken as from 0.82 to 0.84. For $e_h = 0.83$, the term $\sqrt{e_h g}$ becomes 5.167 and

$$v = 5.167 \sqrt{\frac{\sin(\beta - a)}{\sin\beta \cos a}} \sqrt{H}$$

Since for a given runner the value of the radical is a constant we may write

$$v = K_v \times \sqrt{H} \qquad (3)$$

and K_v may be called the *Speed Constant*.

For the conditions $\beta = 135°$, $a = 40°$ and $e_h = 0.83$, the constant K_v is about 7.0. For a given runner where D, H and n are known, the speed constant can be calculated as follows:

$$K_v = \frac{v}{\sqrt{H}} = \frac{\pi D n}{60\sqrt{H}} \qquad (4)$$

Thus the different runner types can be compared as regards their different speeds. The constant will also show whether a further increase of the speed is possible. Should the speed constant be considerably larger than 7, then it may be assumed with certainty that either the guaranteed speed is higher than the best speed (the speed at which the runner yields the maximum efficiency) or that the nominal diameter of the runner is larger than the mean diameter D.

Criterion of Capacity.

The quantity of water discharging from a given opening in a certain time, say 1 sec., is Q = Const. $\times \sqrt{H}$, if H is the head at the center of the opening. Hence $Q/\sqrt{H}$ is a constant for a given opening. We call this constant the "specific discharge" and use for the same the symbol:

$$Q_1 = \frac{Q}{\sqrt{H}} \text{ cub. ft. / sec.} \qquad (5)$$

In other words, the specific discharge from an orifice is the discharge in cubic feet per second when $H = 1$ ft.

Take into consideration the entrance area of the runner, $A = \pi D B \times k_1$, where k_1 is a factor less than 1, necessary in order to consider the difference between total circumference and open circumference due to the ends of vanes and buckets. The speed of the stream normal to this entrance area is the radial speed component c_r, which, like all speeds of a given runner, is a function of $\sqrt{H}$, i. e., $c_r = k_2\sqrt{H}$. But passage area multiplied by speed of flow normal to the area equals discharge; therefore

$$Q = A c_r = \pi D B k_1 k_2 \sqrt{H}.$$

Further, express the width of the guide case in parts of the runner diameter D, or $B = k_3 D$. (For the same type of runner k_3 will be nearly constant for all runner sizes.) Substituting this value we obtain

$$Q = \pi D^2 k_1 k_2 k_3 \sqrt{H} = K_q D^2 \sqrt{H}. \qquad (6)$$

where $K_q = \pi k_1 k_2 k_3$ and may be computed for a given runner by the equation

$$K_q = \frac{Q}{D^2\sqrt{H}} = \frac{Q_1}{D^2} \qquad (7)$$

K_q is the *Capacity Constant* of the runner. The capacity constant of a runner is its specific discharge with the runner diameter reduced to 1 ft. Since K_q will have nearly the same value for all runners of the same type, the capacity constant is a criterion for the capacities of different runner types.

Composite Speed-and-Capacity Characteristic.

Knowing the speed constants and capacity constants of different runner types we are not yet able to say to what extent each type meets the requirement of highest speed with highest capacity. We may have two runners with different values of K_v and K_q and yet both runners may be equivalent when we consider capacity and speed together. Another criterion must be introduced which will be a proper combination of K_v and K_q. This combination could be made in various ways, but the most convenient one was indicated by Prof. Camerer, of Munich, and the noted turbine designer, Mr. Baashuus. This new criterion may be derived as follows:

Since

$$v = \frac{\pi D n}{60} = K_v\sqrt{H}$$

we may write

$$n = \frac{60 K_v \sqrt{H}}{\pi D}$$

Also

$$K_q D^2 = Q_1$$

or

$$D = \sqrt{\frac{Q_1}{K_q}}$$

By substitution

$$n = \frac{60 K_v \sqrt{H}}{\pi\sqrt{\frac{Q_1}{K_q}}} = \frac{60 K_v \times \sqrt{K_q}}{\pi} \times \sqrt{\frac{H}{Q_1}}$$

Fig. 7. The "Trump" Runner.
(Trump Mfg. Co., Springfield, Ohio.)

The power of a turbine is $H\text{-}P = \frac{Q H e}{550}$, where e is the total efficiency of the turbine. This may be written $H\text{-}P = kQH$; as a rule e is taken at 80%, so that $k = 1/11$. Substituting in the equation for n, above, the value

$$Q_1 = \frac{Q}{\sqrt{H}} = \frac{H\text{-}P}{k H \sqrt{H}},$$

we get

$$n = \frac{60 K_v \sqrt{K_q}}{\pi} \times \frac{\sqrt{H}}{\sqrt{\frac{H\text{-}P}{k H \sqrt{H}}}}$$

$$= \frac{60 K_v \sqrt{K_q}\sqrt{k}}{\pi} \times \frac{H\sqrt[4]{H}}{\sqrt{H\text{-}P}}$$

That is,

$$n = K_t \times \frac{H\sqrt[4]{H}}{\sqrt{H\text{-}P}} \qquad (8)$$

where

$$K_t = \frac{60\sqrt{K_q} K_v \sqrt{k}}{\pi} \qquad (9)$$

K_t may be called the "type constant" or *"Type Characteristic"* of the runner. It is a combination of the speed and capacity constants, and both determine the type of the runner. The

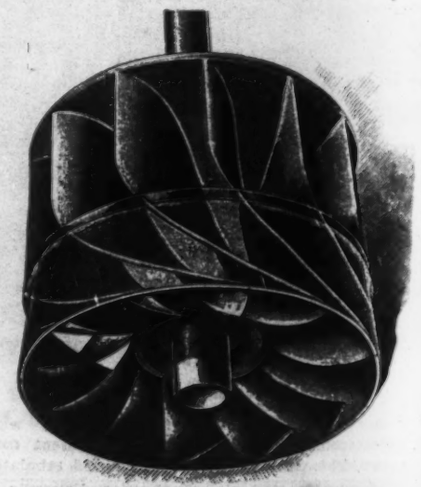


Fig. 8. The "Alcott High-Duty Special" Runner.
(Risdon Alcott Turbine Co., Mt. Holly, N. J.)

convenience of this constant will be apparent, when we write Eq. (8) in the following form:

$$K_t = \frac{n\sqrt{H\text{-}P}}{H\sqrt[4]{H}} \qquad (10)$$

by which formula K_t can be figured directly from the speed, power and head, which data can be obtained easily and seldom differ from actual values. No dimensions of the runner and

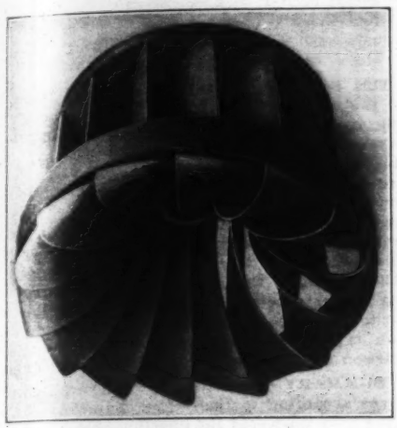


Fig. 9. The "Leviathan" Runner.
(Risdon Alcott Turbine Co., Mt. Holly, N. J.)

neither the discharge nor the efficiency need be known, and yet the efficiency is considered because the formula for K_t contains k which is a function of e. Thus, turbines of the same capacity and speed constant but with different efficiency will have a different type characteristic. Hence K_t is an absolute criterion for turbines in reference to the aim: Highest speed and highest capacity with good efficiency.

The meaning of K_t can be found by assuming $H\text{-}P = 1$ and $H = 1$, when $K_t = n$ in revolutions per minute, i. e.: The type characteristic is the speed in r. p. m. of a turbine diminished in all dimensions to such an extent as to develop 1 HP. when working under the head $H = 1$ ft.

In Germany the term "specific speed" (spezifische Geschwindigkeit or spezifische Umlaufzahl) and the symbol n_s are used for K_t. The writer prefers, however, not to use this term for the following reason: The term "specific discharge" is used for $Q_1 = Q/\sqrt{H}$, and the term "specific power" is used for $H\text{-}P_1 = H\text{-}P/H\sqrt{H}$, which quantities are the discharge and power under the head $H = 1$ ft. Correspondingly the term "specific speed" should denote the speed at $H = 1$ ft., i. e., $n_1 = n/\sqrt{H}$.

As n_1 is used very frequently as characteristic of a given runner, the term "specific speed" should be reserved for n_1 and the term Type Characteristic has been chosen for K_t.

Characteristic Constants of the Various American High-Speed Runners.

THE DAYTON GLOBE IRON WORKS CO., DAYTON, O.

The Dayton Globe Iron Works Co. is the manufacturer of the world known "American" turbines. The last two types of runners arrived at by this concern are the *"New American"* and the *"Improved New American"* runner. The difference in the design of these two runners is seen from Figs. 3 and 4. In order to increase the capacity, the height has been increased and the entrance edge inclined, thus the mean diameter D has been reduced and the speed increased, while the minimum passage area at a is kept ample. The discharge end of the bucket has also been changed. In order to increase the actual discharge area and so decrease the discharge speed the bucket has been drawn down and outward to a spoonlike discharge. The radius of curvature of the spoon seems to be too small, however; the outward discharge could be made more effective by a larger spoon. Nevertheless the capacity and efficiency of this runner are very good, and its success over the *"New American"* runner is remarkable, as regards the aim of increased speed and capacity.

The data for a 19-in. *New American* runner are: $H = 25$ ft.; $H\text{-}P = 80$; $n = 339$; $60Q = 2{,}128$ cu. ft. per min. From these we find:

Speed constant

$$K_v = \frac{\pi D n}{60\sqrt{H}} = \frac{\pi \frac{18}{12} 339}{60\sqrt{25}} = 5.62$$

Some engineers prefer to express all speeds in parts of the spouting velocity, $\sqrt{2gH}$, in the form $v = K_v'\sqrt{2gH}$; or $K_v' = \frac{1}{\sqrt{2g}} \times K_v$. In the present case this constant is

$$K_v' = 5.62 \div \sqrt{2g} = \text{about } 0.7.$$

From the specific discharge $Q_1 = \frac{Q}{\sqrt{H}} = \frac{2{,}128}{60\sqrt{25}}$ = 7.0933, we find: Capacity Constant

$$K_q = \frac{Q_1}{D^2} = \frac{7.0933}{(\frac{18}{12})^2} = 2.829$$

The Type Characteristic is:

$$K_t = \frac{n\sqrt{H\text{-}P}}{H\sqrt[4]{H}} = \frac{339\sqrt{80}}{25\sqrt[4]{25}} = 54.24$$

In the same way the constants for the other sizes have been calculated. Their mean values are:

"New American."

$K_q = 2.8$
$K_v = 5.6$
$K_t = 54.1$

The *Improved New American* runner figured in the same way will be found to have a speed constant considerably larger than that corresponding to $\beta = 135°$ and $\alpha = 40°$. As the speed n (r. p. m.) must be assumed to be correct—it is based on Holyoke tests— and the angles β and α do not exceed 135° and 40° respectively (β is about 135°; α seldom exceeds 35°), the discrepancy can be due only to the fact that the nominal diameter is larger than the mean diameter D. Measuring several runners the writer has found that the nominal diameter is taken near the fillet. The ratio of the mean diameter and nominal diameter was found to be about 0.97. The runner constants have been calculated with D = 0.97 × Nominal Diameter, and their values are:

"Improved New American."

$K_q = 3.43$
$K_v = 7.1$
$K_t = 79.0$

THE PLATT IRON WORKS CO., DAYTON, O., SUCCESSORS TO STILLWELL-BIERCE CO.

To meet the demand for turbines for low, medium and high heads this company is manufacturing different types of water turbines, both radial inward-flow and outward-flow, pressure and pressureless turbines. Here only the *Victor Turbine Type A* for low and medium heads will be taken into consideration. There are two patterns of the runner, Victor Type A, the *Standard Capacity* runner and the *Increased Capacity* runner (Fig. 5). Both have the same speed—only the capacity varies.

One characteristic feature of the Victor runner is the large number of buckets. It seems to the writer, however, that there are no reasons to make so many buckets either for strength or for efficiency—on the contrary, it is advisable to reduce the number of buckets of low head runners in order to increase the capacity and avoid small widths of the chutes near the runner hub.

The average values of the characteristic runner constants are:

Victor "Standard Capacity."	Victor "Increased Capacity."
$K_q = 3.26$	3.59
$K_v = 6.1$	6.1
$K_t = 63.5$	66.6

JAMES LEFFEL & CO., SPRINGFIELD, O.

James Leffel & Co. manufacture the well-known Double wheel, designed first by James Leffel as a combination of two runners, one being a pure radial, the other a radial and downward discharge runner. To increase the capacity of this runner one had to bulge it out more and so the new Double wheel was brought out, which like all high-speed runners discharges centrally and outwardly.

The special feature of this *Improved Samson* wheel, Fig. 6, is the partition wall subdividing the runner into two sections. The upper half is a solid casting, the lower half has steel-plate buckets. Although manufacturing reasons may have been prevailing, it is more than doubtful whether the addition of the partition wall is an advantage. Without going any further into this matter only a few reasons for this opinion of the writer may be stated: The partition wall increases the friction, decreases height and capacity, increases possibility of clogging and, if not built so that it coincides with the water flow lines, it decreases the capacity still more and also the efficiency. One advantage could be claimed, namely, that the regulation by a cylinder gate will not affect the efficiency of the turbine very much; but this is the case only for small variation of load when the cylinder gate closes the upper part of the runner.

The average values of the characteristic constants are:

"Improved Samson."

$K_q = 3.18$
$K_v = 7.07$
$K_t = 73.1$

THE TRUMP MFG. CO., SPRINGFIELD, O.

The Trump Mfg. Co. is one of the best known turbine manufacturers, especially abroad. At the

Fig. 10.

Fig. 11.

FIGS. 10 AND 11. RUNNERS OF "NEW SUCCESS" AND "SMITH" TURBINES.
(Morgan Smith Co., York, Pa.)

time when European concerns were not willing or prepared to build radial inward-flow turbines or were not starting to do so, many of such wheels were installed by the Trump Mfg. Co. all over the European continent. Like the Samson runner the *Trump* runner, Fig. 7, has steel-plate buckets; it resembles in form the other American runners.

The average values of its characteristic constants are:

"Trump."
$K_q = 3.52$
$K_v = 5.87$
$K_t = 63.4$

RISDON ALCOTT TURBINE CO., MOUNT HOLLY, N. J.

The types of runners manufactured by the Risdon Alcott Turbine Co. are very numerous, due to the fact that this concern is a combination of two turbine manufacturers, the T. H. Risdon Co. and T. C. Alcott & Son.

Fig. 12. The "Jolly McCormick" Turbine Runner. (Wellman-Seaver-Morgan Co., Cleveland, Ohio.)

The average values of the two types that interest us most (Figs. 8 and 9) are:

"Alcott High Duty Special."	"Leviathan."
$K_q = 2.25$	$K_q = 2.96$ (?)
$K_v = 5.46$	$K_v = 7.47$ (?)
$K_t = 46.7$	$K_t = 74.1$

The mean values for the *Alcott High Duty Special* runners have been calculated from values of runner diameters up to 48 ins. The runners 54 ins., 60 ins. and 66 ins. diameter have a reduced capacity.

From the values of the *Leviathan* runner characteristics it appears that, as in the Improved New American runners, the nominal diameters must be larger than the real mean diameters of the runners. The values of the speed constant K_v seem to be too large, and those of the capacity too small for the large values of K_t.

S. MORGAN SMITH CO., YORK, PA.

The S. Morgan Smith Co. manufactures the noted *McCormick* and *New Success* turbines (Fig. 10). Recently a new type has been put on the market by this company under the name of the *Smith* turbine, Fig. 11. This new runner has attained somewhat higher values for K_t than those of the Improved New American runner, which was the leading runner in this respect until the *Smith* turbine appeared.

The average values of the characteristic runner constants are:

"McCormick."	"New Success."	"Smith."
$K_q = 2.96$	2.8	3.68
$K_v = 5.35$	5.88	7.26
$K_t = 51.4$	55.	80.6

THE WELLMAN-SEAVER-MORGAN CO., CLEVELAND, O.

The standard runner manufactured by the Wellman-Seaver-Morgan Co. is the *Jolly McCormick* runner (Fig. 12). Its characteristics are exactly the same as those of the McCormick runner manufactured by the S. Morgan Smith Co.

The Wellman-Seaver-Morgan Co. manufactures also a *Special* runner with increased capacity and increased speed. Judging from the test of a 33-in. turbine, the values of the characteristic runner constants are:

Wellman-Seaver-Morgan "Special."
$K_q = 3.2$
$K_v = 6.49$
$K_t = 68.2$

ALLIS-CHALMERS CO., MILWAUKEE, WIS.

The manufacture of hydraulic turbines was begun by the Allis-Chalmers Company only five years ago. Following in the beginning the European principle, turbines were designed to suit given conditions and requirements in every instance. But the advantage of standard turbines being fully appreciated, long and exhaustive studies have been made in this direction by the company's engineers.

At the present time, the developing work on Allis-Chalmers standard turbine types is practically completed. In order that all ordinary combinations of speed and capacity may be covered by these "standards," the company is building six different types of radial inward-flow runners and two types of impulse-wheel buckets. Here only the high-speed runner, Type F, interests us. This type was designed to have at least a type characteristic $K_t = 68$. The first runner of this type, a 30-in. runner, was tested in the Holyoke testing flume. The result of this test, although within the expectations of the engineers, was far beyond the anticipations of the company. The following data obtained from the test are interesting.

At best efficiency, 82.5%, the turbine developed power at the rate $H\text{-}P_1 = 2.28$ with a speed $n_1 = 52$. Thus the values of the runner constants are:

Allis-Chalmers "Type F."
$K_q = 3.89$
$K_v = 6.8$
$K_t = 78.7$

With increased speed, the efficiency went down very slowly, but the output was increased. At speed proportional to $n_1 = 59$, the power was proportional to $H\text{-}P = 2.34$. Thus

$K_q = 3.80$
$K_v = 7.72$
$K_t = 90.4$

This is not the place, nor is it the intention of the writer, to enter into a discussion of the efficiencies and all those points which must be taken into consideration in the question will this runner fulfill the requirements of a standard runner. The efficiency of a standard runner must not go down too fast when it is working under other than normal conditions; in other words, the runner must be what is termed "flexible." The 30-in. Type F. runner of the Allis-Chalmers Company is in this respect remarkably successful. The information that the writer was able to gather about the other American types is not sufficient to attempt a comparison of the same in regard to their flexibility.

SUMMARY.—Arranging now the various runner types according to their type characteristics, we shall have answered the question how far the different concerns have progressed in reference to the aim of "highest capacity and highest speed." The table below contains this summary. The Allis-Chalmers runner *Type F* and the Wellman-Seaver-Morgan *Special* runner have been omitted in the table, as their characteristics are known only for one runner size.

As European engineers and European textbooks frequently refer to the American "high-speed runners," and as it appears that the information they have about the same is very inaccurate, the runner characteristics have been given also in the metric system.

For 1 ft. = 0.30479 m., 1 cu. ft. = 0.028317 cu. ft., and 1 HP. = 1.01385 cheval-vapeur, or metric horsepower, the following conversion constants are to be used when converting from the foot system into the metric system.

Metric System.		Foot System.
Q_1	=	$0.0313\ Q_1$
n_1	=	$\frac{1}{0.552}\ n_1$
$H\text{-}P_1$	=	$6.0246\ H\text{-}P_1$
K_q	=	$0.552\ K_q$
K_v	=	$0.552\ K_v$
K_t	=	$4.447\ K_t$

MEAN VALUES OF CAPACITY CONSTANT, SPEED CONSTANT AND TYPE CHARACTERISTICS OF AMERICAN HIGH-SPEED RUNNERS.

Values in foot-and-pound system. Figures in parentheses are the corresponding values in metric system.

Name of runner type.	Manufactured by	Capacity Const. $K_q = \frac{Q_1}{D^2}$	Speed Const. $K_v = \frac{\pi Dn}{60\sqrt{H}}$	Type character'c $K_t = \frac{n\sqrt{H\text{-}P}}{H\sqrt[4]{H}}$	Velocity coefficient. $K'_v = \frac{V}{\sqrt{2gH}} = \frac{K_v}{\sqrt{2g}}$
Smith	S. Morgan Smith Company	3.68 (2.032)	7.26 (4.008)	80.6 (358.5)	0.905
Improved New American	The Dayton Globe Iron Works Co.	3.43 (1.893)	7.1 (3.92)	79 (351.2)	0.885
Leviathan	Risdon Alcott Turbine Company	2.96 (1.634)	7.47 (4.125)	74.1 (329.5)	0.931
Improved Samson	The James Leffel Mfg. Company	3.18 (1.755)	7.07 (3.902)	73.1 (325)	0.881
Victor Increased Capacity	The Platt Iron Works Co.	3.59 (1.982)	6.1 (3.368)	66.6 (296)	0.761
Victor Standard Capacity	The Platt Iron Works Co.	3.26 (1.80)	6.1 (3.368)	63.5 (282.5)	0.761
Trump	The Trump Mfg. Company	3.52 (1.943)	5.87 (3.24)	63.4 (282)	0.729
New Success	S. Morgan Smith Company	2.75 (1.518)	5.88 (3.245)	55 (244.5)	0.733
New American	The Dayton Globe Iron Works Co.	2.8 (1.545)	5.6 (3.09)	54.1 (240.5)	0.69
McCormick Jolly McCormick	S. Morgan Smith Co., Wellman-Seaver-Morgan Co.	2.8 (1.545)	5.35 (2.954)	51.4 (228.6)	0.667
Alcott High Duty Special	Risdon Alcott Turbine Company	2.25 (1.242)	5.46 (3.015)	46.7 (207.8)	0.681
Risdon Double Capacity	Risdon Alcott Turbine Company	1.7 (0.938)	5.9 (3.256)	43.8 (195)	0.735

A TUNNEL UNDER THE CHICAGO RIVER at La Salle St. is proposed, to replace the old tunnel which was destroyed by removing the roof to increase the navigable depth of the river. It will be 300 ft. long, exclusive of approaches, and the roof will be 27 ft. below the water surface, or 10 ft. lower than in the old tunnel. The plans provide for two concrete tubes. They would be built in open cofferdams, half the width of the tunnel being closed at one time. The cost is estimated at $1,500,000.

THE WEAR OF BRIDGE PINS in an early German pin-connected bridge was the subject of observations recently on the demolition of a wrought-iron railway bridge, built in 1863, on the Argermünde-Stralsund Railway. This was a half-through Pratt truss bridge with curved top chord, of 102 ft. span, c. to c. and 12.6 ft. depth of truss at center. The pins were 2 ins. in diameter, and were of steel. The bridge was removed because too light for its present day traffic, but has always been in good shape and will be re-erected as a footbridge. During demolition, all pins were measured at the center and in the seat of the chord eyebars. The wear was found to be surprisingly small. The top-chord pins, being protected from the weather, showed little rust, but the bottom pins were rather rusty. Only three pins showed wear greater than 1/250-in., and in these three cases the wear averaged about 1/25-in. The "Zentralblatt der Bauverwaltung," from which these figures are taken, does not refer to the difference of hardness of pins and bars, but as the pins were steel and the bars wrought-iron it might be expected that the bars would get the principal wear. In fact, the source states that the pin-holes were very rough, so that close measurements were impossible.

Recent Experience with Bank Protection Works at Pine Bluff, Ark.

As many of our readers will recall, extended newspaper accounts were published in the latter part of November and early in December, regarding the disastrous effects of floods in the Arkansas River at Pine Bluff, Ark. Particularly wide publicity was given to the report that the town was being endangered because of certain works which the United States engineers had put in place. A circumstantial report was also widely circulated, that appeals had been made to the Government for permission to use dynamite at a certain point to save the town, that permission had been refused, and that the dynamite was thereupon exploded surreptitiously with highly beneficial effect.

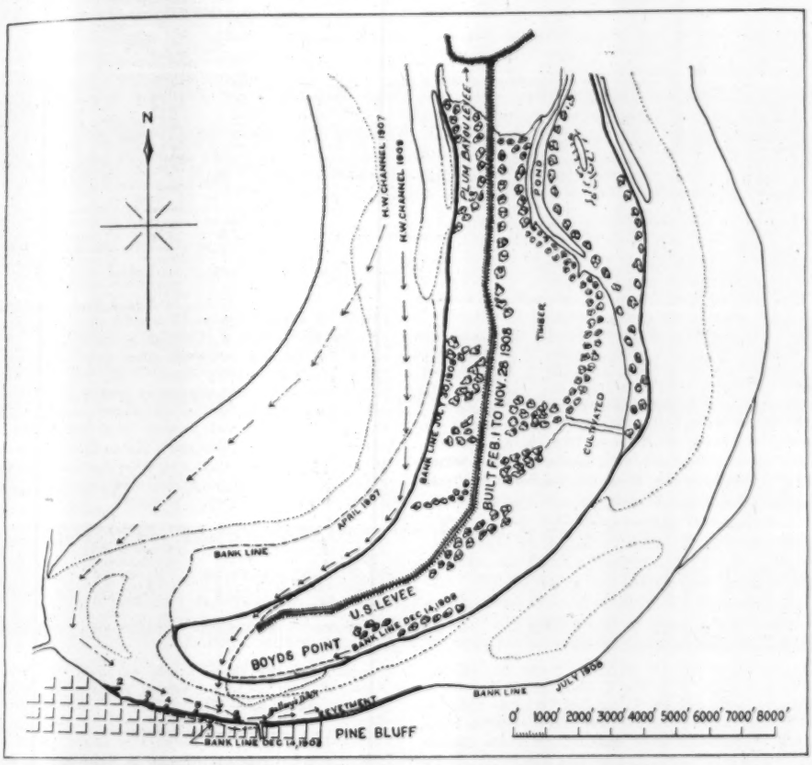
It seemed to us desirable that the engineering profession, at least, should know the actual facts regarding the situation in Arkansas. To some extent these have been already presented in the letters of Mr. Charles H. Miller, recently published, and the further correspondence by Mr. Miller and an engineer resident of Pine Bluff, which was printed in our correspondence columns January 14. We have endeavored, however, to obtain a full and authoritative statement concerning the conditions at Pine Bluff, and at our request Major M. L. Walker, Corps of Engineers, U. S. A., in charge of the U. S. Engineer Office at Little Rock, has prepared for us an article which is printed below.

Our readers will note from Major Walker's article that the serious caving at Pine Bluff and consequent destruction of valuable property were due to no fault of the mattress protection which had been put in place, but to the fact that needed repairs upon it had been neglected, owing to the failure of Congress to make the necessary appropriations. As has been plainly pointed out in the recent correspondence which we have printed on bank protection, durability of such structures is to be secured only by prompt making of necessary repairs. It does not follow that these repairs need be very extensive or very expensive; but a hole once started, into which the current can find entrance and begin its work of undermining, the destruction of the work is extremely rapid. Engineers well understand, in matters of street and highway paving, how "a stitch in time saves nine." In the mattress protection of river banks, particularly with the unstable soil of the Mississippi Valley, a stitch in time often saves ninety-and-nine.

Major Walker's contribution follows:

Replying to your letter of Dec. 11, 1908, concerning certain reports of floods from Pine Bluff, Ark., I take pleasure in furnishing you the following memorandum and accompanying tracing.

The protection works along the town front, consisting of the numbered dikes and bank revetment, were built between 1885 and 1893, as funds became available. The dikes were of pile and stone construction and the revetment consists of a brush mattress 120 ft. wide, weighted with stone and with a varying amount of stone paving on the bank above the mattress. Practically no repairs have ever been put on this work, owing to lack of funds.



MAP OF THE ARKANSAS RIVER AT PINE BLUFF, ARK., SHOWING EROSION OF BANK AND CHANGES OF CHANNEL, 1908.

During the spring rise of 1908 some slight caving took place along the town front, and it being known that the old works were in a more or less bad condition, arrangement was made whereby, with a small amount of government funds available and the cooperation of the citizens (organized as an Improvement District), and the county, the works above Mallory's Ditch, which were in most dangerous condition, could be repaired before the next high-water season.

The United States was without plant for this work, and attempt was made to let it to contract, but the results were entirely unsatisfactory. Hence, it was finally decided to take plant away from the upper White River and do the work by force account. The plant was started from Batesville, Ark., Nov. 2, 1908, but owing to delays due to low water it did not reach Pine Bluff until Nov. 27, 1908.

In the meantime very unusual rains in Oklahoma, Oct. 21, 22 and 23, 1908, produced a sudden and most unexpected rise in the Arkansas River, causing considerable damage along the town front between Dikes 3 and 5. According to all precedents this rise should have been of short duration and, as the Mississippi River was low, should have run off particularly rapidly. The river, however, fell slowly and on Nov. 1, 1908, the government, improvement district and county commenced emergency protection work, consisting principally of large brush fascines constructed on the bank, much as described by Mr. C. H. Miller in Engineering News of Oct. 22, 1908. These were rolled into the river, held by cables, and some weighted with stone, but mostly depended upon silting for final anchorage. Caving was successfully checked Nov. 5, 1908, and preparations were again made to start the permanent work.

Late in November, due to still more unusual rains, another and greater rise in the Arkansas River occurred, cresting at Pine Bluff on Dec. 5, 1908. Caving recommenced between Dikes 3 and 5, proceeding downstream as Boyd's Point wore away, and the chief point of attack of current shifted in this direction. The emergency measures were resumed and carried on continuously until Dec. 8, 1908. As a final result the river bank is altered as shown on the tracing, Dec. 14, 1908. All the protection works from Dike 3 to 500 ft. below Mallory's Ditch are destroyed; and about 90 buildings, six of which were brick structures, were lost.

As to the intimation that the government works were at fault or that the government refused to permit necessary action to be taken for the protection of the city, I presume this refers to the requests, when people were in an hysterical condition, for permission to make a cut-off across the levee and Boyd's Point. These requests were not granted as it was entirely impracticable to make a cut-off in time to affect the then existing situation, and its final accomplishment would have been detrimental to Pine Bluff and to navigation interests on the river. The dynamiting of Boyd's Point, of which so much was made in the daily papers, is not believed to have accomplished anything. The tracing shows how the point must have been wearing away, and a few charges of dynamite could have had little if any effect. That the levee did not affect the situation is clearly proven by the fact that the water did not reach the levee at any point during the first rise and was scarcely up to the toe of the levee in low places during the second rise.

On Dec. 15, 1908, active operations were commenced under a new project for continuous revetment of the bank with brush mattress 120 ft. wide, weighted and sunk with stone, and stone paving of banks. Provided the river remains down until Feb. 1, 1909, this project can be advanced sufficiently to make all secure until the next low-water season, when its completion will depend upon further appropriations by Congress.

In conclusion I wish to say that the most cordial relations exist between the citizens of Pine Bluff and the representatives of the government, and I know of no dissatisfaction or criticism at present.

The basis of this communication is information from Mr. Wm. Parkin, U. S. Assistant Engineer, who was present in Pine Bluff during most of the trouble, directing the work of the combined forces.

Very respectfully,

M. L. Walker,
Major, Corps of Engineers, U. S. A.

Little Rock, Ark., Jan. 7, 1909.

Annual Meeting of the American Society of Heating and Ventilating Engineers.

The fifteenth annual meeting of the American Society of Heating and Ventilating Engineers was held at the Engineering Societies' Building, New York City, on Jan. 19, 20 and 21. Much of the time was given up to routine business, and to committee reports, though ample time was left for social diversion.

The following officers were elected for the coming year: President, Wm. G. Snow, Boston; First Vice-President, August Kehm, Chicago; Second Vice-President, B. S. Harrison, New York City; Secretary, W. M. Mackay, New York City; Treasurer, V. G. Scollay, Brooklyn, N. Y.

Comparatively few papers by individuals were presented, but many of the committee reports were in the nature of engineering papers. In addition to all these, topics for general discussion were presented. A "question-box" scheme was ordered put into effect whereby such topics as were desired discussed at meetings were sent to each member previous to the meeting.

PAPERS.—Mr. W. W. Macon, of New York City, presented "Air Cooling by Refrigeration." This paper showed a method of computing the refrigerating capacity necessary in a plant to cool a given air supply from one temperature and humidity to a desired temperature and relative humidity. In many respects the problem discussed is the reverse of heating-plant design. The principal exception to such a simple view is in the fact that, with air saturated with vapor, far more heat per degree change of temperature must be subtracted for falling temperatures than for rising. This is, of course, on account of condensing the vapor in one case and extracting its latent heat of vaporization. The heat exchanges in the room to be cooled were outlined as an approach to determining the amount of cooled air necessary. Computations for the cooling of the air to final temperature, for the cooling of the vapor to saturation point, for the liquefaction of the proper portion of the vapor and for the cooling of the remaining vapor to

final temperature were graphically carried out by a series of superimposed charts.

"Notes on the Design of Furnace Heating Systems," was presented by Prof. J. D. Hoffman, Purdue University, Lafayette, Ind. In this paper two points of view were considered: One in which air was a heat carrier, the other in which air was a health preserver. The actual calculations for the heating of a ten-room dwelling were shown, as well as the check calculations for ventilation.

In "The Effect of Wind on Heating and Ventilating," Mr. H. W. Whitten described some actual tests on leakage about window openings, under various wind pressures. It was found that on the windward sides of a building, with forced circulation, the expanding warm air exerts sufficient pressure to overcome the tendency to inleakage for winds up to about 4 mi. per hr. For an actual 1-16-in. sash crevice with a wind of 15 mi. per hr. an average of 146 cu. ft. per lin. ft. per hr. was found. It was also found that the wind caused a slight vacuum on the leeward side of a building, so that the outflow on this side exceeded the inflow on the windward side by about 15 to 20%.

COMMITTEE REPORTS.—The report of the Committee on Fan-Blast Heating was, in substance, a reprint of an article in "The Metal Worker," of Oct. 5, 1907, containing new data on such topics as rise in temperature in the heater, amount of radiating surface, drawing or blowing air through the heater, concentration, etc.

The Committee on Corrosion of Wrought Iron and Steel Pipes made a progress report only. One series of tests, similar to those carried on by the chairman of the committee a year ago and noted in Engineering News, Jan. 30, 1907, p. 132 had been made. The results did not appreciably favor either kind of pipe.

The report of the Committee on Rating of Heating Boilers was verbal, but was accompanied with a reprinted report by Wm. Kent as an aid to the discussion. The matter of ratings was not definitely settled, but was left to the committee for further study with a view of publishing definite standards.

TOPICS FOR DISCUSSION.—The first general topic taken up for debate was "Air Cooling by Means of Air Washers." Strong opinions were expressed that mere air-washing was a distinct problem from cooling and humidifying, although similar apparatus might be used for both. The results desired in any particular case could not be determined, it was held, from the general commercial catalog data broadly circulated by manufacturers.

An attempt was made to arouse discussion on the topic "The Duty of the Society in Informing the Public of Lack of Ventilation in Public Halls, Nickel Theaters, Etc.," and of "The Necessity of Applying Ventilation Laws to Old Buildings as Well as New." Finally a resolution was adopted calling public attention to the dangers of poor ventilation in old buildings and small show places. The resolution provided for a general publicity committee to be assisted by one member from each state in securing agitation.

"State Control for Heating and Ventilating Engineers" was another topic for discussion, but the idea found few champions. Most members preferred to extend the influence of the society by educational methods among architects, health boards, etc.

"A Sliding Scale of Indoor and Outdoor Temperatures for Gaging The Capacity of Heating Plants," was a topic put on the program because of the need of many members for a method of testing a heating plant in spring or fall to ascertain its ability to maintain at 70° indoor temperature with 0° outdoors. It appeared that 15 years ago a committee of the society had spent some three years on the problem with only partial success. It was the general opinion that the number of variable conditions was so great that the desired simple method was impossible. A committee was appointed to conduct a series of tests and to seek again some desirable scheme.

Expenditures on the Panama Canal.

In a recent number of the "Canal Record" the following tables of costs and expenditures were given. The figures cover the period from May 4, 1904, to Oct. 1, 1908.

The total classified expenditures from appropriations for Canal construction, amounted in round numbers up to Oct. 1, 1908, to $83,275,000.

"Classified" expenditures do not include the following: Advances to Panama R. R. (amounting to nearly $5,000,000); purchase of Panama R. R. stock; services rendered and material sold to individuals and companies (amounting to about $2,500,000); and all material and supplies on hand not drawn from store.

Table I. divides this total sum into 17 items, and into three periods, which are: May 4, 1904, to July 1, 1907; July 1, 1907, to July 1, 1908; and July 1, 1908, to Oct. 1, 1908. The items show separately, the expenditures for the Departments of "Civil Administration," "Sanitation," and "Construction and Engineering"; for buildings pertaining to the above departments; for 'Military Protection"; for Construction and Maintenance of Water-Works, Sewers and Roads, called 'Municipal Improvements"; for "Lands purchased and expropriated"; and for expenditures in connection with the Panama R. R., which do not include loans to the Panama R. R. Co. from the United States Treasury, secured by interest-bearing notes.

Table II. exhibits the total expenditures of the Department of Construction and Engineering (Item No. 3, Table I.), divided by periods into expenditures for "Work"; 'Plant"; and "General Administration"; amounting in round numbers to $51,512,000, up to October, 1908.

"Work" includes all direct charges, and all indirect charges not included under "General Administration." "Plant" represents the total plant purchased to October, 1908. "General Administration" includes the expenses of the Office of the Chief Engineer; the Disbursing Officer; the Examiner of Accounts; the Secretary of the Commission; the Chief Quartermaster's Department; the Meteorological and River Hydraulic Service; and the Y. M. C. A. work in the Commission clubhouses; and also the cost of general surveys, and of transportation of the employees of the Commission on the Isthmus by the Panama R. R. Co., and expenses of telephone and telegraph service.

Table III. shows the expenditures for the Department of Construction and Engineering under the three items of "Work," "Plant," and "General Administration," divided into the three periods. It also gives the unit costs, both wet and dry, the yardage and unit costs, and a complete comparison of these costs. These figures show that there has been a constant reduction in unit costs. They show that dry excavation, for the first quarter of the present fiscal year, cost 63 cts. per cu. yd. for direct charges, and 12 cts. per cu. yd. for general administration, making a total of 75 cts. Dredging cost 63 cts. per cu. yd. for direct charges, and 2 cts. per cu. yd. for general administration. The average cost per cu. yd. for excavation was 40 cts. for the direct charges, and 8 cts. for general administration, making a total of 48 cts. as against an average cost of 57 cts. for these two items for the last fiscal year, a reduction of about 15%.

The expenditures for work other than excavation reported on the same table, comprise the following: Sundry preparatory and construction work pertaining to the locks and dams at Gatun, and on the Pacific slope, consisting of special surveys and borings; the shutting off and pumping out of old channels; the construction of trestles for filling of toe-walls and other purposes; the filling of the toe-walls; the construction of the railroad tracks necessary for the above named purposes, and work in connection with the rock-crushing, receiving and handling plant for Gatun Locks.

TABLE I.—"CLASSIFIED" EXPENDITURES; MAY 4, 1904—OCT. 1, 1908.

	May 4, 1904, to July 1, 1907.	July 1, 1907, to July 1, 1908.	July 1, 1908, to October 1, 1908.
(1) Department of Civil Administration	$1,445,000	$704,000	$232,000
(2) Department of Sanitation	4,624,000	2,310,000	474,000
(3) Department of Construction and Engineering	20,643,000	24,210,000	6,659,000
(4) Buildings for Department of Construction and Engineering, including quarters	6,374,000	1,924,000	252,000
(5) Buildings for Department of Civil Administration	83,000	220,000	33,000
(6) Buildings for Department of Sanitation	865,000	305,000	58,000
(7) Buildings for Military protection	30,000	54,000	
(8) Construction of Electric Light plants	82,000	91,000	53,000
(9) Purchase of steamers Panama and Colon	1,300,000		
(10) Double-tracking Panama Railroad	937,000	119,000	
(11) Relocation of Panama Railroad	221,000	1,448,000	188,000
(12) Docks and Wharves leased to Panama Railroad Company	403,000	100,000	11,000
(13) Municipal improvements for the benefit of the cities of Panama and Colon, to be repaid to the United States	2,015,000	234,000	32,000
(14) Municipal improvements for the benefit of the Canal Zone settlements, paid from Congressional appropriations	2,059,000	1,463,000	179,000
(15) Lands purchased and expropriated	59,000		36,000
(16) Buildings, tools and machinery, Cristobal shops, leased to the Panama Railroad Company	170,000	4,000	
(17) Locomotives, cars, and equipment, loaned to and used by the Panama Railroad Company	588,000	22,000	
Totals	$41,898,000	$33,188,000	$8,189,000

TABLE II.—EXPENDITURES OF DEPARTMENT OF CONSTRUCTION AND ENGINEERING.

	Work.	Plant.	General Administration.	Total.
May 4, 1904, to July 1, 1907	$12,322,000	$7,236,000	$1,085,000	$20,643,000
July 1, 1907, to July 1, 1908	13,495,000	7,621,000	3,094,000	24,210,000
July 1, 1908, to Oct. 1, 1908	3,981,000	1,879,000	799,000	6,659,000
Total, May 4, 1904, to Oct. 1, 1908	$29,798,000	$16,736,000	$4,978,000	$51,512,000

FORESTRY OPERATIONS on a large scale are proposed in a report just made by a British Royal Commission. According to press despatches, the Commission was appointed to consider the possibilities of forest planting as a means of providing work for the unemployed. Reports state that the Commission recommends that 9,000,000 acres be planted in Great Britain and Ireland during the next 80 years. The cost of this work would be met by a loan. It is estimated that after the 40th year the forests would be self-supporting. It is also stated that imports of timber into Great Britain in 1907 were valued at $160,000,000. Included in the membership of the Royal Commission was Mr. H. Rider Haggard, who is popularly known only as a writer of fiction, but who for a number of years past has devoted himself largely to agricultural and labor conditions in England.

TABLE III.—TOTAL EXPENDITURES AND UNIT COSTS OF WORK. DEPARTMENT OF CONSTRUCTION AND ENGINEERING.

	May 4, 1904, to July 1, 1907.			July 1, 1907, to July 1, 1908.			July 1, 1908, to October 1, 1908.			May 4, 1904, to October 1, 1908.		
	Expenditures.	Cubic yards.	Unit costs	Expenditures.	Cubic yards.	Unit costs	Expenditures.	Cubic yards	Unit costs	Expenditures.	Cubic yards	Unit costs
Dry Excavation—												
Work	$11,249,000	8,581,152	$1.32	$11,944,000	17,579,958	$0.61	$1,454,000	5,495,228	$0.63	$26,647,000	31,656,338	$0.84
Plant	6,863,000		.79	4,276,000		.24	1,197,000		.22	12,336,000		.39
General administration	924,000		.11	2,686,000		.15	692,000		.12	4,302,000		.14
Totals	$19,036,000	8,581,152	$2.22	$18,906,000	17,579,958	$1.07	$3,343,000	5,495,228	$.97	$43,285,000	31,656,338	$1.37
Wet Excavation—												
Work	762,000	4,375,048	.17	1,020,000	10,399,417	.10	388,000	4,672,514	.09	2,170,000	18,849,979	.12
Plant	373,000		.09	2,695,000		.26	432,000		.11	3,500,000		.19
General administration	78,000		.02	234,000		.02	79,000		.02	391,000		.02
Totals	$1,213,000	4,375,048	$.28	$3,949,000	10,399,417	$.38	$899,000	4,672,514	$.22	$6,061,000	18,849,979	$.33
Total Excavation, Wet and Dry—												
Work	12,011,000	12,959,200	.92	12,964,000	27,979,375	.46	3,842,000	9,567,742	.40	28,817,000	50,506,317	.57
Plant	7,236,000		.56	6,971,000		.25	1,629,000		.17	15,836,000		.32
General administration	1,002,000		.07	2,920,000		.11	771,000		.08	4,693,000		.09
Totals	$20,249,000	12,959,200	$1.55	$22,855,000	27,979,375	$.82	$6,242,000	9,567,742	$.65	$49,346,000	50,506,317	$.98
For Construction Work other than Excavation—												
Work	311,000			531,000			139,000			981,000		
Plant				650,000			250,000			900,000		
General administration	83,000			174,000			28,000			285,000		
Totals	$394,000			$1,355,000			$417,000			$2,166,000		
Grand totals	$20,643,000			$24,210,000			$6,659,000			$51,512,000		

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Entered at the New York Post-Office as Second-Class Matter.

A general inventory of the natural resources of the United States, declared by President Roosevelt to be the first inventory of the kind attempted by this or any other nation, has just been made public as the major part of the report of the National Conservation Commission, just transmitted to the Congress of the United States. All of the inventory portion of the report is reprinted elsewhere in this issue, together with an abstract of the remainder of the report and of the President's letter of transmittal.

This whole subject of the natural resources of our country is of such commanding interest at the present moment that we are sure our abstract of the report will be welcomed by the thousands of readers of Engineering News who will never see the complete report. We may add, however, that those desiring a copy of the portions of the report thus far printed can doubtless secure the same by addressing their representatives in Congress. A good cause would be aided if, at the same time, there was expressed a word of appreciation for the work of the Commission and in behalf of an adequate appropriation for establishing its work on a permanent basis.

The Chicago crib disaster last week, whose death list promises to reach or even exceed 60, is the greatest and in some respects the most shocking of the numerous fatalities which cloud the record of the Great Lakes cribs. The ten or fifteen tunnels which the larger cities on the Great Lakes have bored out under the water to bring them an improved water-supply have nearly all witnessed a fatal accident. Storm, ice, explosion, rock and water were active to swell the list of disasters. But of the accidents in either crib or tunnel, no previous one is quite as painful as the burning and drowning of the 50 to 60 laborers on the Southwest Tunnel intermediate crib.

Of the detail facts and responsibilities concerning this accident we will doubtless be informed soon through the coroner's inquest, which it is promised will be unusually searching. At present we have only the general picture: A timber cofferdam structure a mile from shore, covering a shaft to the tunnel below, and housing day and night near a hundred men, while carrying enough dynamite to blow the whole edifice into the air; fire came, met no opposition whatever, and did its work quickly and thoroughly.

As in other fire calamities the impression of preventable error, of human blamableness, is irresistible: the mind refuses to believe that fire risk was reduced to the degree necessary for reasonable protection, or that sufficient means of combating fire or else escaping were provided that the occupants might have a fighting chance for their lives. But at present the matter rests with impressions; the inquest should bring out the facts.

In the meantime we tender our appreciation to the Cook County coroner who has broken with tradition by drafting experienced technical men upon his jury. Three mature and favorably known engineers are members of the body. Their technical knowledge and responsibility should direct the inquiry to effective purpose and ensure impartial, explicit findings.

There is a refreshing novelty about the announcement, elsewhere in this issue, of a large industrial corporation that it has a perplexing problem for whose solution it is willing to award a fair prize in open competition of designs. The company evidently desires to engage ability in as free a circle as possible, since it is advertising its offer in detail—and that among a class of men little likely to increase the company's sales, so that press-agent suspicions may be eliminated. We trust the offer may be successful, by bringing about a satisfactory comparison of the available solutions and thus pointing out the proper design to adopt. We say this because the departure is worth extending. There are numberless technical problems which can thus be brought into the forum of competitive design with advantage to all concerned. The manufacturer of machinery should be the last to find objection, since he is nowadays carrying an excessive burden of gratis designing for prospective clients, the cost of which he must squeeze out of his successful cases.

What is probably the most stupendous attempt ever made by man to regulate, by artificial means, one of the forces of nature is the proposed use of Lake Superior as a storage reservoir. It has been several times pointed out that with proper regulating works at the outlet of Lake Superior it would be possible to greatly reduce fluctuations in level of the other Great Lakes. At present the general effect of the works hitherto carried out at the Sault—both those for the improvement of navigation and those for the development of water power—is to lower the general level of Lake Superior. But by the comparatively simple process of placing regulating works at the outlet of the lake, its level could be held continually at a high point, and the enormous area of the lake would thus be available to raise the level of the water in the lower lakes during dry seasons of the year. To make possible these controlling works, however, it will be necessary to condemn the water power companies now operating there, or at least compel their operation under restrictions. A bill was introduced in Congress, on Jan. 5, appropriating $250,000 toward the expense of condemning the water power properties. It is probable, however, that by extending the regulating works over the free channel to a sufficient extent the interference with the present water power plants could be made comparatively small.

Montreal is now experiencing its annual outbreak of typhoid fever, apparently due, as heretofore, to failure to make sure that the citizens are supplied with pure water. If we understand the situation rightly, it is not the water-supply of the whole city which is chiefly responsible for these winter outbreaks, but merely the supply of certain of the outlying districts. These districts, or some of them, if we are correctly informed, are supplied by one or more private companies. For some unexplained reason, the city is not able, or if able fails to attempt, to ensure a proper water-supply for these unfortunate sections. The typhoid death rate of Montreal, although far above what it should be for a city located as it is, is not so very high; that is, taking the city as a whole. We have not the detailed figures at hand, but we presume that the typhoid statistics by wards would show very high rates in some portions of the city. According to a report of a committee of the Montreal Medical-Chirurgical Society, submitted on Jan. 8, the typhoid death rate of Montreal per 100,000, during the last five years for which the record is available, was as follows: 1903, 31.45; 1904, 31.89; 1905, 18.11; 1906, 37.08; 1907, 32.26.

If the Montreal daily press correctly reflects the situation—and we have no reason to doubt that it does—it would appear that the health authorities of that city have no very adequate conception of precautionary measures against typhoid; or at least are somewhat at sea in the matter of making certain the cause or causes of these annual outbreaks. It appears that the health authorities are proposing to take samples of water in different parts of the city, in order to ascertain the root of the trouble. One would suppose that before this time the relation of the water-supply to these annual typhoid outbreaks at Montreal would have been definitely determined, and that with the approach of each winter, pending needed reforms in the character of the water-supply, the health authorities would keep such watch on local water-supply conditions as would enable them to give the citizens fair and ample warning to protect themselves by boiling the water, if they had not already provided such constant protection as would be afforded by the best types of domestic filters.

No little consternation was caused in Philadelphia, and towns between there and Reading which take some or all of their water-supply from the Schuylkill River, by the recent shutting down of the Reading sewage-treatment works by the contractor who was under obligation to operate the plant. While the operation or non-operation of this sewage-disposal plant may make less difference in the safety of the water-supply of Philadelphia and other towns than many people in those municipalities think, it is nevertheless not pleasant to contemplate the possibility of having the operation of a plant of this sort subject to the whims or caprices of an individual acting in accordance with his own notions of his private rights and interests. The shutdown, it appears, was due to some difficulty which the contractor had in securing from the city of Reading one or two of his monthly payments for operating the plant. If this contractor really felt that the plant as being operated by him afforded any real measure of protection to the public water-supplies on the Schuylkill below, how could he justify himself in stopping the operation of the works for a moment, until he had at least taken every legal step possible to ensure that he would be paid for his work?

It is stated that the plant was closed two days or so, and that during that time untreated sewage was discharged into the Schuylkill River at the rate of some 5,000,000 to 7,000,000 gals. per day. This and the public agitation which followed the closing of the plant raises an interesting question, already suggested in this note, as to what protection the plant, at best, really affords to the water-supplies of the municipalities below. We do not propose to go into this subject in detail, either as regards the character of this particular plant, the way in which it was operated when it was at work, the voluma of water into which the effluent was discharged, or the distance between the effluent outlet and the various water intakes below. The main point is that the health authorities of some, at least, of the communities below, and also the state health authorities, considered the shutdown of the plant a very serious matter—so serious that the State authorities were on the point of intervening, if they did not actually do so.

Of course, any well-designed and properly-

operated sewage-treatment plant will lessen the dangers of infection from the sewage which passes through it. But to put much reliance upon a sewage-purification plant for the water-supply of a community below is altogether too much like leaning on a broken reed. In this particular case, if we are rightly informed, well towards as much untreated sewage from the city of Reading is going into the Schuylkill River as is being discharged there by the sewage-disposal works in question, and will continue to do so until extensions to the works are completed. The raw river water, therefore, is unfit to drink, in any case, at any point within the range of the influence of the Reading sewage. Philadelphia has nearly completed sufficient filtering plants to filter all of its water-supply from both the Schuylkill and Delaware rivers; some of the communities above it and nearer Reading are still drinking the untreated river water, unless we are mistaken; and all or practically all of the communities between Reading and Philadelphia that have sewerage systems are discharging their untreated sewage into the Schuylkill. The sooner these intermediate cities install high-grade water filtration plants the better. This they ought to do, if they continue to draw water from the Schuylkill, even though Reading and all the towns below it treat every drop of their sewage by the most improved method of the day.

Since its organization in 1904 the Joint Committee on Concrete and Reinforced Concrete, composed of subsidiary committees from each of three national engineering societies, has been recognized as a potential authority on concrete. Although no report has been given out in the four years, the profession has looked to it for some official utterance, based on the tests and observations it has been engaged upon, which would establish such standards as the novelty of the material would allow. Apparently in realization of the difficulty in formulating such standards, the Committee up to the present has wisely refrained from going on record with any report until such report could fairly hope to remain undisturbed, at least a few years, for it is evident that the value of standards is entirely dependent upon their stability. At last, however, the committee has prepared a report, the first public evidence of which was its presentation as a report of the Special Committee on Concrete and Reinforced Concrete to the annual meeting of the American Society of Civil Engineers, noted on another page of this issue. It is to be expected that each of the other contracting societies will take up the report at its coming annual convention.

The report itself consists of categorical statements of the advantages and limitations of concrete work, general instructions as to materials, specific formulas for the design of one limited field of concrete construction, and finally a list of recommended unit stresses. The first part is entirely general and so platitudinous as almost to apply to any style of construction. Where any doubt as to theory, methods or action can possibly exist, such doubt is emphasized. It bears in no way the mark of authority or certainty but rather that of hesitancy and doubt. The latter part, on design and unit stresses, is more after the manner to be expected from the Joint Committee in its final report, but it is only a small part of the discussion on design which properly seems to be in the scope of the committee's instruction. The report strikes the reader as a compromise between one party desiring strict specifications and one advocating glittering generalities.

This document is called a "Progress Report" and, ostensibly, has been presented to furnish the basis for a wider discussion among the members of the respective societies. It seems quite evidently to be the result of a feeling on the part of the committee that, although there is not a sufficiency of knowledge, or at least agreement as to knowledge, concerning the subject, it is high time, after four years' work, that something should be published. As such a progress report, then, it is quite acceptable. It cannot, however, be used as the system of standards which it is expected the committee some day will promulgate. On this point warning should be given, for, judging from the peculiar construction of the report and the attitude of certain members of the committee, it appears that there is a tendency to consider this progress report in the light of a more-or-less complete specification or instruction, instead of the very incomplete, curiously unbalanced document it really is. This latter attitude was well shown at the recent meeting of the National Association of Cement Users, where one new specification was adopted and one old one materially changed so that the wording and arrangement would agree with that of the "Progress Report." Such action clearly assumes that the latter is an adopted specification of authority, from which minor regulations and specifications should be formed.

Although there can be some question as to the necessity of such a report from a body whose main duty is to arrive at some definite conclusions, no matter how long it may take, the members of the committee have the right to their own opinions on that subject. If treated merely as the framework for discussion there can be no possible danger in the report. But with the wide publicity to be given it in its introduction to the three societies, there is certain to be fostered an inference of finality, which is not justified either by the contents of the report or, we have reason to believe, by the intention of the majority of its signers. It should be regarded merely as the passing impressions of a body of experts on a changing subject and should be so discussed. Any attempt to consider it as final should be discouraged.

Those of our readers who are interested in the current discussion of waterway transportation will read with interest, we are sure, the report of the Waterways Commissioner of Wisconsin, a full abstract of which is given on another page of this issue. The great bulk of the literature on waterways to be found in the newspaper press and in popular magazines is for the most part devoted to thrashing over old straw. It is refreshing, therefore, to find the work of an original independent observer, who thinks for himself and who does not take current statements as truth without making inquiry on his own account. Judge Reid, the Wisconsin Commissioner, remarks in his report:

> One not engaged in this work can scarcely understand the unreliability of the so-called information volunteered in regard to river subjects. It is absolutely necessary to personally inspect almost every object or situation of which you desire to gain any knowledge.

Another extract, indicating his original method of conducting his bureau, relates that the act creating the Commission was passed with the belief that the office should be to some extent a publicity bureau. Concerning this Judge Reid says:

> Upon taking hold of the work I soon discovered that conditions were so entirely different from what I had supposed them to be that I was scarcely prepared to conclude as to what should be made public until I had myself examined the questions involved.

A perusal of Mr. Reid's conclusions, which he summarizes at the opening of his paper, shows that he is far from the position of most waterway advocates. That he has been in some part misled by lack of technical knowledge and by incompleteness of his observations seems very probable. At the same time, his statements well deserve consideration.

We have ourselves pointed out in these pages the fallacy of the current idea that the economy of water transportation depends directly upon the depth of water available. This is true for transportation on open water, but the same does not apply to river transportation. Where vessels have to stand the stress of waves, as they must in lake or ocean navigation, the restrictions as to hull design make the depth of water exceedingly important; but for craft to be used on inland rivers only, it is almost, if not quite certain that a moderate depth of water is just as advantageous for transportation as unlimited depth.

It is, of course, desirable that there should be a good margin between the bottom of the hull and the bed of the stream; but given [illegible]s, it is probable that navigation can be car[illegible] on as cheaply on Western rivers with vesse[illegible]f only 4 or 5 ft. draft as with vessels draw[illegible] twice as much. In fact, it was pointed [illegible]ut by Major Symons, of the Corps of Engine[illegible] nearly a dozen years ago, that the barge tran[illegible]tation of coal on the Ohio and Mississippi ri[illegible] even under the conditions then existing, re[illegible]sented an even lower ton-mile cost than is a[illegible]ed in ocean transportation.

Judge Reid points out that the int[illegible]t and maintenance charge on the capital act[illegible]y expended in river improvement is really [illegible]part of the total cost of water transportation. [illegible]s fact also has been pointed out in this journ[illegible]. His further statement that waterway impr[illegible]ments should not be undertaken except where [illegible] total benefit to navigation will be sufficient [illegible] make the investment a paying one, is eminently [illegible]ound.

His discussion of the methods of oper[illegible]ion of steamers on the Western rivers, and also [illegible]n the waterways of Europe, is exceedingly interesting. His proposal to place a fixed rail in the bed of the river, to be made use of in a manner similar to the familiar chain towing system used in Europe, is doubtless chimerical. His suggestion, on the other hand, that the system of towing barges astern should replace on Western rivers that of pushing them ahead, seems well worth consideration. It is doubtless true that the stern wheel steamboat, pushing its huge fleet of barges, is a system of navigation that has been evolved from the peculiar conditions on the Western rivers, particularly the necessity for moving an enormous amount of traffic down-stream on a flood wave. If it is proposed to operate the year round, however, and to handle vessels under low water conditions, the system of towing the barges astern would seem to have many advantages. Particularly noteworthy is the idea, previously brought forward, we believe, by President Roosevelt, that the whole Mississippi River, with its tributaries, should be operated as one system, so that a barge loaded at one point on a tributary, say the Arkansas, would pass down to the main stream and then up it, and possibly up some other tributary to its final destination, without breaking bulk.

The final proposal of Judge Reid that the Government should itself go into the river transportation business seems hardly worth serious consideration. The difficulties in administering such a huge enterprise, and in keeping pace with changing commercial conditions under necessary governmental restrictions, would seem to make the scheme practically out of the question. On the other hand, it is possible that something might be done by the Government in the way of experimenting with different methods of operating river transportation lines to determine what really is most economical. Beyond question, the method to be adopted for improving this network of Western rivers and the saving or expending of many millions of dollars turns upon the question of what is the most economical method of transportation upon them.

If vessels requiring only 6 ft. draft, say, can be operated as economically on the Western rivers as vessels drawing 10 to 12 ft., then there can be saved the expenditure of many millions of dollars which would be required if the demands for "14 ft. through the valley" are gratified. Or if the other alternative is preferred, the same expenditure will place a much larger mileage of the main river and its tributaries in condition for economical navigation.

An Important Possibility in Working-Drawings.

With all the improvement in engineering methods during the last century, one of the most important tools has remained in a very primitive condition—the drawing, which is the indispensable link between design and construction. Though calculating instruments and drafting tools have been refined so as to increase vastly their convenience and efficiency, our drawings have made no advance whatever, the introduction of blueprinting alone excepted. Their general form has

remained unchanged, and to-day drawings are still the same bulky, awkward blanket sheets as were produced by the very earliest engineers.

In every machine-shop, in every construction or design office, there may be found a table on which is spread a ragged, disorderly mass of greasy blueprints, and these must serve to control all details of the construction. They represent the final form in which the labors of the designer come before the workman, who converts them into a concrete embodiment. As the whole of the processes through which the machine or construction must pass is based on these drawings, they require to be handled a countless number of times. They are constantly studied to determine shapes and dimensions or other specifications and to guide the succession of processes. In the machine shop they are needed in the designing room, in the manager's office, at the foreman's desk, on the bench and at the machine, and at each of these places there must be not only one but many drawings, all of them available for reference at any time. In the field, it is true, the drawings will not be found in as many places, not because they are less often needed, but simply because it is impossible to keep and handle them except under specially-provided conveniences, as in the foreman's shanty. A field-book or reference handbook, containing many times as much information as the drawings, can be carried around the work without trouble and consulted anywhere. Were the drawings only capable of being put in similar compact and protected form, what a boon it would prove to engineering practice!

The glaring defects of the present large-size drawings are rarely given a thought, perhaps. But this is only because we so completely take it for granted that nothing better, nothing more convenient and systematic is available; in short that the system cannot be improved upon, however badly it may need improving. So, no doubt, before the introduction of blueprints few people thought of complaining against the inconvenience of handling white-paper drawings in field or shop. Yet if we were now compelled to abandon the rapid reproduction methods of which blueprinting is typical, and go back to white paper drawings and tracings, we would be justified in making serious complaint.

Now to an object-lession of improvement, one that we believe contains fairly revolutionary elements of convenience and simplicity: Some time ago, during an inspection trip over a large public work under construction, the engineer guide sprang a surprise by saying that he always carried a full set of the working plans in his pocket. As the plans numbered something over a hundred, surprise was natural; but he proved the fact by pulling the plans out of his pocket and explaining with their help how the work was designed and how the contractor was building it. Stopping by the side of a foundation pit, we looked over the drawings, including the general layout, the plans of the separate subdivisions and the detail drawings of the various constructive elements. There was no table on which to spread out the plans, and none was needed; yet no sheets blew around or tore, and it was possible to study the drawings as leisurely and carefully as might be desired.

These drawings were about 8 × 10 ins. in size, and were conveniently bound in a limp leather backing-strip folding over to the size of a large pocket bill-case. Two such cases, if we recall correctly, covered the entire work. And the vital fact is that each of the small sheets contained fully as much matter, drawn in just as much detail, as the ordinary working-drawing of say 18 × 24 ins. The secret of this surprising result was simple: the original drawings really had been made of the ordinary large size, but they were executed with such careful regard to the needs of photographic reduction that they could be photographed on an 8 × 10-in. plate without losing legibility; thin-paper prints were made from the negatives, and these small prints were used as working plans. So skilfully had the work been done that every detail, every dimension figure, was read as easily as from the customary large-sheet drawing.

The whole arrangement probably cost a little more, initially, than the customary set of blueprints. We have worked out an estimate of extra cost, and give it farther on, to show the most unfavorable aspect. On a half-million dollar contract the drawings may cost as much as $500 more, in a bad case. But such an amount is surely of no moment if any real advantage is secured. In the case cited, there can be no doubt that in the long run a striking economy was secured: a saving not only in calculable cost but also in time, in temper and in quality of work.

This successful use of photographic reduction was really a very logical thing. Drawings reproduced in books, or in the pages of Engineering News for example, are treated in exactly the same way as was followed in the case cited. Let the reader call to mind any particular piece of work, comprising say ten sheets of drawings, and conceive these distributed as illustrations in the pages of a text-book. Fifteen or twenty pages of a rather large book would accommodate them, perhaps, with the scales of reproduction which we commonly see in such works. Would not the drawings in that form be capable of giving him exactly as much information, fully as clearly, as the blueprints? Is there any use to which the blueprint adapts itself which the smaller form would not meet? Is there not an immense gain of convenience and adaptability? The answers cannot be other than affirmative. Now, the engineer of the work above referred to did no more than duplicate the processes used in making such a set of book illustrations, only that he stopped short of making blocks for the printing-press, and instead made photo-prints from the reduced photographic negative.

But why did he use any photographic process, it may be asked; why did he not simply make his original drawings or tracings on 8 × 10 in. sheets? A complete answer to this is furnished by even a small amount of experience in drawing for small-scale reduction. It is true that a drawing such as may be found in a technical book *can* be originally drawn to that scale, with complete satisfaction as to accuracy and clearness; *but* a very high degree of skill would be required for this, in fact an impracticable degree of skill. On the other hand, it is very easy to attain the same degree of relative accuracy and clearness in a larger-scale drawing, to the effect that the large drawing when reduced photographically will meet every requirement of easy legibility, sharpness and completeness of detail and accuracy.

We are firmly convinced that what was done in the case cited can be done just as readily in most cases indeed in all other cases, and that the large-size blueprint can be made the exception instead of the universal thing. No highly specialized knowledge is required to apply the method, nothing more in fact than an appreciation of the relation between rate of reduction and minimum line-spacing and line-thickness. Whatever difficulties may seem to stand in the way of carrying out the method are bound to disappear in the face of its astonishing possibilities. Think of a huge drawer-case full of file tracings, replaced by a couple of dozen dockets of 8 × 10 films stacked in a single desk drawer! Is this not a real and meritorious advance over present conditions?

That some of the difficulties which the method would encounter are of a kind requiring careful study to surmount cannot be denied. The most serious difficulty would arise in the case of detail drawings of structural steelwork, where it has become customary to crowd the drawings with minutely complex lines of rivet-spacing figures. Indeed, it is not obvious that even the most determined effort would be able to bring *all* such drawings within the scope of small-size reduction. Experienced structural and bridge draftsmen may be able to give a definite answer in this matter.

But this specialty excepted, the difficulties are only apparent, we believe. Two general cases cover practically the entire range: (1) Where the larger part of a drawing is sufficiently open to adapt itself to the reduction of scale, but a small part of the sheet shows much finer detail, which would be lost on reduction. This case can always be dealt with by drawing the detail part separately, to larger scale, a solution applicable both to a drawing in which the denser portion is due to passing a detail section at some point, and to a drawing in which the actual external lines are close or intricate at one point while being gross and open over the rest of the sheet.

(2) Where the entire surface, or most of the surface, is covered with close detail. This also is amenable to ready simplification in every instance, sometimes by more rational draftsmanship, sometimes by subdividing the matter among several sheets. In an elevation of a long shop building, for instance, the draftsman may have attempted to indicate every detail line of pier, mullion or cornice along the whole front, although the purpose of the elevation is only to show general outline and disposition and spacing of panels, etc. (otherwise it is what we might call an exhibition drawing or picture, a class not included in this discussion). Or, he may have tried to make one drawing do the duty of two, a general outline elevation as before and a detail drawing of its various fittings, which is easily remedied by assigning the two functions to different sheets.

One of the cases just mentioned is worth special note, because it is a survival of earlier times, a barbarism which fortunately is dying out. We refer to the case of a large, open drawing which at one point or another is utilized as a detail drawing, as by passing a section which shows very fine detail. No well-ordered drafting-room permits this practice to-day, but in the past it was rather common. A machine-tool would be shown in general front elevation, we will say, to a scale three or four times as large as really necessary for the major part of the drawing, and then one small part would show the front cut away, revealing the details of an intricate mechanism. Such a drawing is both wasteful of space and ineffective as to its chief purpose, namely, to show the machine as a whole. More rational methods of treatment, as found in all good drafting-rooms, are more effective, economical and convenient; and these adapt themselves very well to photographic reduction. Once the principle is recognized that no part or no view should be drawn any larger than necessary to show clearly, and that therefore the relative scale (i. e., relative with regard to detail) is always a fixed quantity, we have a sufficient basis for the method here discussed.

This same principle has done away with another vicious custom of former times, namely, lettering a drawing with letters of widely varying size, or placing poorly executed and almost microscopic lettering on a finely made large-scale drawing. Architectural practice alone continues to harbor such obsolete procedures. Everywhere else, rational progress in drafting practice has tended toward uniform size of lettering, and lettering designed for legibility instead of quaintness. The fundamental ideas of this progress are the very ones which find their logical conclusion in applying photographic reduction in the manner described.

It should be worth while to get some idea of the cost of the photographic-reduction method, at least of its comparative cost, alongside the conventional blueprint method. This may be done without much trouble, at least in so far as to get an estimate of the maximum difference, since individual cases will differ widely.

Let us assume a job requiring ordinarily eight drawings, of which two are general and six are detail drawings. As already remarked, it will often be possible to get the same matter into the same number of reduction drawings; but to be quite conservative, let us say that each detail sheet will spread over two of the new sheets, so that in all 14 drawings will result. Now the actual time needed for drawing the parts should be the same in both cases. If it be thought, however, that it might take longer to draw the same matter on twelve sheets as on six, it is also to be remembered that there will generally be some saving in tracing, since drawings for photographic reduction may be made on white paper just as well as on tracing-cloth. So far, then, the draft-

ing time is not increased under the method suggested.

But to observe the requirements of line spacing and line thickness for satisfactory reduction may take the draftsman longer at first than to execute a drawing suitable for blueprinting. Practice should make the difference disappear. We may assume, however, as an initial condition that the drafting time is increased 10% on this account; in this, of course, we exclude the time spent in designing or detailing and have regard only to the time devoted to tracing or finishing the drawing. The time spent in lettering, putting on dimensions, notes, etc., will be increased rather more, and permanently so, because it needs much more careful work to letter for reduction than for direct blueprinting. An increase of 25% in the lettering time is a sufficient average allowance.

The cost of photographing and printing is to be set against the cost of blueprints. But one negative serves for many prints, while each additional blueprint costs as much as the first. The comparison, therefore, will vary a trifle with the number of prints. We assume six prints of each drawing for our average case.

Other minor assumptions are included in the detailed estimate, which we make up as follows, on the basis of $6 per day drafting, $4 tracing and finishing in the case of the blueprint method and $5 in the case of the photographic method (to allow for more skill in finishing and lettering):

BLUEPRINT METHOD.

Two general drawings—			
Each, Laying out, 1d.....	$6.00		
Tracing and finishing, ½d...	2.00		
		$8.00	
Two drawings.....			$16.00
Six detail drawings—			
Each, Laying out, 3d.....	$18.00		
Tracing and finishing, 2d..	8.00		
		$26.00	
Six drawings.....			156.00
Checking 8 drawings, 4d.....			24.00
Six blueprints each, 48 prints at .15.....			7.20
Total			$203.20

PHOTOGRAPH METHOD.

Two general drawings—			
Each, Laying out, 1d.....	$6.00		
Finishing, ⅔ × ½d., + 10%..	1.83		
Lettering, ⅓ × ½d., + 25%..	1.04		
		$8.87	
Two drawings			17.75
Twelve detail drawings—			
Each, Laying out, 1½d.....	$9.00		
Finishing, ⅔ × 1d., + 10%..	3.67		
Lettering, ⅓ × 1d., + 25%...	2.08		
		$14.75	
Twelve drawings.....			177.00
Checking 14 drawings, 5d.....			30.00
Photographing 14 drawings, at .50.....			7.00
Six prints of each, 84 prints, at .10.....			8.40
			$240.15

The difference is about 18%, or something less than $5 per drawing. It represents a maximum difference, according to our best judgment, the assumptions having been made rather on the safe side.

The case rests on the unimportance of this small extra cost when compared with the positive lasting advantages gained. If it is worth anything at all to be able to transmute a bulky mass of drawings to pocket size, we submit that it must be worth much more than enough to render the extra cost of drawings entirely insignificant.

LETTERS TO THE EDITOR.

A Plea for Wood Preserving Processes.

Sir: Engineers should read with interest Mr. Ernest Hartmann's article in Engineering News, Dec. 31, 1908. It should prove instructive to students of "economy." A great work can be done by all the scientific and technical journals in educating the unenlightened or backwoods investors to the use of wood preservation, so that they will realize its real economy and demand it in specifications for construction. Surely the preservation of timber is a matter of capital and interest, in prolonging the life of timber by from five to ten years. The money saved, by the use of any good wood preservative, would decrease operating expenses and pay interest on a large amount of stock or bonds.

When the railway directors have this subject brought squarely before them, with actual savings worked out in definite figures they will not be long in taking advantage of the increased revenue available. Every engineer of maintenance knows what the "renewal sheet" means toward the "percentage of operation" and how the superintendents try to keep this figure to a minimum. If these men would spend half as much time in explaining some kind of wood preservation to the presidents or owners, in showing the advantages derived and the money saved as they do in figuring how to squeeze one more year's wear out of a tie already rotten, they would be better off. I believe the officials could be interested enough to give a trial treatment of all renewal timbers until the whole system was converted. Owners and officials need to be educated in the following lines; renewal labor saved, timber renewals reduced to a minimum, second-grade timber used as well as "all-heart."

The days of a supposed "economic first cost" have passed. It is an expensive saving in the end and goes hand in hand with a receivership. There is a large field to be worked on in this supposed "economical construction." While we cannot all have masonry and steel bridges, we can go a great ways in that direction by the general use of wood preserving processes in all our work.

This treatment will do more to preserve our forests than any one thing else. One reads of forest fires and ruthless destruction of small trees by the woodsmen. These losses are harder to fight than the loss due to rot and neglect. In fighting the first two losses, one is fighting against quick returns on investments. In the case of the last loss, one is fighting for quick returns by getting some 300% more usage from the timber. A special expenditure by our Bureau of Forestry in demonstrating these things to the railways and other large users of timber would soon produce as noticeable an effect on the forests as on the renewal sheets of the companies.

Certain methods of treating timber have been thought unduly expensive. The treated timber could be gotten from only certain plants or the green timber had to be shipped to certain places to be treated. This is all done away with now by the open-tank processes which give as good results as the vacuum processes. Suitable tanks can be constructed and taken to the timber for treatment "on the ground." Such outfits should be maintained by all the railroads. Any one interested can get reliable literature from any of the preservative manufacturers or from the Bureau of Forestry. It seems to me that the Bureau should have no trouble in having Congress pass an act providing that all timber in government structures should have preservative treatment.

Respectfully yours,
Echols McBee.

Ashville & Carolina R. R. Co., Ashville, N. C., Jan. 5, 1909.

Engineers and Scientific Spirit and Practice in Health Board Work.

Sir: Of late years there has been a growing tendency for engineers to take the initiative in many matters relating to the public health. In matters of water supply and sewerage, it is already recognized that the duties of the engineer relate quite as much to sanitary as to structural questions.

The successful efforts of the engineer, based upon scientific investigation, to safeguard the public health in these directions might well be taken as indicating the desirability of placing our health departments upon a scientific basis rather than to leave them longer to depend upon "highly arbitrary rules based chiefly upon traditions which antedate nearly the whole of our present scientific knowledge." (The expression quoted is from the editorial column of the Engineering News, of October 8, 1908.)

It is discouraging to the engineer, after having given a community pure water and effective sewerage, to find the health department relying upon tradition to supply the weapons for continuing the fight against disease, and it is more than discouraging to have a water supply, which has been rendered absolutely safe by up-to-date scientific methods, condemned by those whose theories of preventative sanitation are the same as those put in practice at Florence and London about 1350, at Geneva in 1545, at Milan in 1630, and Marseilles in 1720.

It is lamentable to find so many health departments today devoting their efforts to matters which the police department could handle much more effectively, and it is worse than lamentable to find health departments regarded as a sort of "catch all" to which all manner of odds and ends of duties can be consigned.

The spectacle of the health officer spending his time in arguing with an owner of an offensive pig sty or cesspool, in laying in wait for a milkman, or in superintending the collection of waste paper, is not reassuring under the theory that the public health is being looked after in the best possible manner.

Because the health department is so equipped that it can put in operation the historic practice of taking cases of contagious diseases to so-called pest houses; of fumigating houses *after* a case of contagious disease has occurred, and of burying the dead from contagious diseases immediately after death; it does not follow that the department is properly equipped for protecting or promoting the public health. Neither is a winning contest with disease to be fought with ash carts and prosecutions.

Give health departments appropriations commensurate with the importance of the public health. [illegible] from the duties of policemen, scavengers and [illegible] Give them well-equipped laboratories in ch[illegible] skilled in the study of disease rather than [illegible] tion of crime.

The splendid work of the modern engine[illegible] ing the danger of epidemics of water-borne d[illegible] those which owe their origin to bad drainag[illegible] influence the public, by example, to appreci[illegible] portance of patient, scientific research in ma[illegible] the public health is concerned, and to bring[illegible] reorganization of health departments along[illegible] of twentieth century ideas.

It will cost money, but I believe it would [illegible] it costs, and I believe that the engineer sho[illegible] prominent place in every up-to-date health [illegible]

Yours very respectfully,
Edwin F. [illegible]

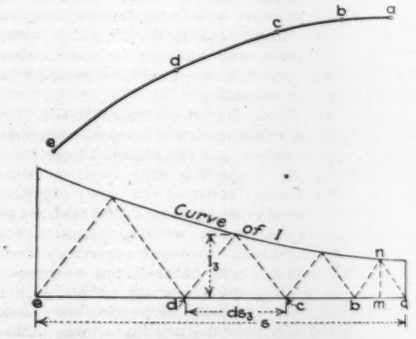
31 Exchange St., Lynn, Mass., Jan. 7, 1909.

[We heartily agree with our correspo[illegible] nt in his main thesis, although perhaps diff[illegible] g on some of the minor points raised by way [illegible] illustration. If one or more engineers in ev[illegible] community would enter upon and persistent[illegible] continue a well-considered campaign of pub[illegible] education along the general lines indicated [illegible] Mr. Dwelley great reforms in health-protective work could be wrought in the next ten years.—Ed.]

A Graphical Method for Subdividing an Arch Ring for Analysis.

Sir: The following procedure is suggested for subdividing an arch ring in analyzing it by the common graphical method which requires the lengths of divisions to be proportional to the moments of inertia, or in applying equation (5), p. 272, of Turneaure & Maurer's "Principles of Reinforced-Concrete Construction."

Referring to the sketch herewith, let it be required to subdivide the half arch-ring, *ae*, into *n* parts, *ab*, *bc*, *cd* and *de*, such that $\frac{ab}{I_1} = \frac{bc}{I_2} = \frac{cd}{I_3} = \frac{de}{I_4}$, where I_1, I_2, etc., represent the moments of inertia of the section at the mid-points of *ab*, *bc*, etc., respectively. If *s* be the length *ae*, $\frac{\delta s}{I}$ any one of the equal ratios, $\Sigma I = I_1 + I_2 +$



$I_3 + I_4$, and I_n the average moment of inertia from *a* to *e* inclusive, then by a simple rule of proportion,

$$\frac{\delta s}{I} = \frac{s}{\Sigma I} = \frac{s}{\frac{\Sigma I}{n} \times n} = \frac{s}{n I_n}$$

which is the equation (5) referred to.

Having thus found $\frac{\delta s}{I}$, rectify *ae* as an axis of abscissas and plot the values of *I* at successive points as ordinates, thus obtaining the curve shown. From *a* draw the line *ar* with a slope $\frac{am}{mr} = \frac{1}{2}\frac{\delta s}{I}$, which makes $\frac{ab}{mr}$ or $\frac{ds_1}{I_1} = \frac{ds}{I}$; continue the construction of similar isosceles triangles in the manner indicated, always using the same slope, thus obtaining the required subdivision along the axis of abscissas.

A B. & S. protractor is convenient for constructing the successive triangles. The last oblique line drawn should, of course, intersect the axis at *e*, but any small excess or shortage of length may be distributed proportionately among the subdivisions.

Unless the springings of the arch are very definitely fixed points, it will not be necessary even to use equation (5), the slope of *ar* being taken at random and the construction terminated when some point along the axis is reached which seems suitable to regard as the springing point.

If the arch-axis *ae* is a segment of a circle, and a protractor is being used, it will be found convenient to

lay off the ab[illegible]sa *ac* by scale proportioned to the central angle in[illegible]d of to the arc length, and thus avoid error due to [illegible] use of dividers.

Yours respectfully,

Andrew B. White.

321 Park [illegible], Swarthmore, Pa., Jan. 4, 1909.

Forests and Snow in the High Mountains of the Western United States.

Sir: In [illegible] issue of Dec. 24, 1908, you quote the following from a paper on the floods of the Mississippi Delta, written by Col. William D. Pickett, and which appears in the November number of the "Proceedings" of the American Society of Civil Engineers.

In other words, forests of average density and at the average altitude of their habitat, 8,000 to 9,000 ft., will preserve the snows of winter from melting two months longer than open areas exposed to the direct rays of the sun.

It is obvious that in writing the above sentence the Colonel lost sight of the snowdrifts scattered over these "open areas" and which remain long after the snow on contiguous forest areas has disappeared; and that he had in mind the "open areas," not occupied by snowdrifts and from which the snow disappears, both by drifting and melting, before it does from the contiguous forest areas. For, on page 1243 of the "Proceedings" in which his paper appears, in speaking of "large areas of open land" along the Continental Divide, he states:

During the storms of winter, there form on the eastern slope snowdrifts deep enough to last very often until snow flies again.

The observations of the writer, extending over a period of more than twenty years, in the high mountains of Utah, Colorado, Wyoming and Montana, lead him to endorse the statement of Col. Pickett, last quoted, and to add that from these snowdrifts interspersed over the unforested areas, and not from the contiguous forest areas, come most of the late summer water so essential for the irrigation of the arid lands of the states named.

Especially is this true of the snowdrifts formed on the unforested areas, above timber line, all of which remain late into the summer, and many of which, as Col. Pickett states, "very often until snow flies again." Water from these snowdrifts continues to flow down the mountain slopes, long after all snow has disappeared from the forest areas below. This water enters, passes through, and out of the forest areas below; giving to a person, whose observations are confined to the forest and do not extend to the unforested areas above timber line—and there are many such observers—the impression that the water he observes flowing through and out of the forest has its source in the forest, whereas, as above stated, it comes from the snowdrifts on the unforested areas above the forest.

Snow on the high mountains of the West always disappears by melting in the following order:

(1) Snow on the unforested areas not collected in drifts.

(2) Snow on the forest areas.

(3) And last, snow in drifts scattered over the unforested areas.

The writer is of the opinion that all persons, including Col. Pickett, who have an intimate knowledge of these mountains will agree that snow on them melts and disappears in the above order. Anyone who cares to go into the high mountains of the West and spend a few weeks there during the summer can very easily verify for himself the above order of snow melting. Doubtless many members of the American Society of Civil Engineers, who attended the annual convention of that Society at Denver last June, and who took the trip over the Continental Divide on the "Moffatt Road" will recall that the only snow seen, on that trip, was in drifts scattered over the unforested areas, all in the forests having melted and disappeared earlier in the season.

In your editorial comments on Col. Pickett's paper you state:

the importance of the forests to the irrigation interests of the Far West is so great that no statement by a high scientific authority to the effect that they are injurious instead of beneficial should be allowed to go uncontroverted.

In this connection it may be of interest to hear from another "high scientific authority," one conceded by all to be the greatest authority on the resources of the West, the late Major John W. Powell, who, in discussing this same subject, wrote:

When the mountain declivities are grassy slopes, the snows of winter drift behind ledges and cliffs and into great banks among the rocks, and they fill ravines and canyons, and are thus stored in compact bodies until they are melted by the summer suns and rains. But when forests stand on the slopes the snows are spread in comparatively thin sheets, and great surfaces of evaporation are presented to the sun and the wind. For all these reasons the forests of the upper regions are not advantageous to the people of the valleys, who depend on the streams for the fertilization of the farms.—Century Magazine, V. 17, p. 920.

Very respectfully,

Jeremiah Ahern.

825 Tenth St., Sacramento, Cal., Jan. 4, 1909.

[Actual observers of relative snow-prevalence in high forested and non-forested areas seem to differ as much in their reports of what they see as do those theorizers who have never been in high mountainous areas. Our correspondent states that those who took the "Moffatt Road" excursion over the Continental Divide in connection with the convention of the American Society of Civil Engineers at Denver, last June,

will recall that the only snow seen, on that trip, was in drifts scattered over the unforested areas, all in the forests having melted and disappeared earlier in the season.

Now it so happens that one of the editors of Engineering News was on that very excursion, and that scarcely any of the marvels of that marvel-seeing day impressed him more than the deep and extensive layer of snow in the evergreen forest on the left-hand side of the train, after a considerable elevation was reached. That was going up. After the timber line was passed he has no recollection of snow until the stop was made at the station on the summit, where there was a large snow bank alongside the track. Going down the other side of the Divide, and on coming into a much less thickly forested area, where the branches of the trees were higher, there was no snow whatever, so far as he now remembers.

The excursion in question antedated the publication of Captain Chittenden's recent notable paper before the American Society of Civil Engineers, which paper has been so fruitful of discussion on forests and snow and water conservation. But the present writer had in mind, at the time of the excursion, a very interesting pamphlet on this very subject of forests as a retardent of snow melting. The pamphlet was written by Prof. L. G. Carpenter, of the Colorado Agricultural College and Experiment Station, Ft. Collins, Colo., and was published by the institution named. Prof. Carpenter's whole discussion, as we now remember it, as well as numerous half-tone views presented by him, went to show that the forests conserved the snow and were a markedly beneficial agency in lessening floods and in conserving water for summer use. We thought at the time of the "Moffatt Road" excursion that what we saw confirmed Professor Carpenter's conclusion.

We venture to suggest that some of the recorded differences of observation and opinion, as regards forests and snow conservation, are due to making comparisons of and deductions from areas, altitudes, sun and wind exposures, dates and other conditions which are not properly comparable.

Obviously, one should compare forested and non-forested areas at the same elevation. As soon as one gets above the timber line there are no forested areas from which deductions can be drawn, and the further up one goes the less comparable is the non-forested area there found with the forested area below the timber line. Given a high enough mountain, the land of eternal snow is reached, where the presence of snow is no more a question of drifts than of forests. Now, since the timber line is really not a line at all, but rather a transition zone from a timbered to a non-timbered area, sometimes extending through a considerable altitude, it can be seen that comparisons of snow conditions above and below the line are likely to be very misleading through differences in temperature. The huge drift far above the timber line, in July or August, and the entire absence of snow below, may be due solely to the difference in elevation, and hence in temperature—otherwise there would be drifts in the open at the lower as well as at the higher elevation.

Finally, we believe that much of the contradictory testimony about the effect of forests on snow conservation and on runoff and floods is due to attempts to compare the uncomparable and to a lack of scientific records.—Ed.]

Notes and Queries.

Referring to the reinforced-concrete tower and tank at Atlanta, Ga., described in our issue of Jan. 7, p. 22, it should have been stated that the design of the tower and tank has been patented.

The Bitulithic Pavement Patent Upheld by the U. S. Circuit Court of Appeals.

A court decision of interest and importance to paving engineers and contractors and to municipal officials was rendered on Jan. 5, 1909, by the U. S. Circuit Court of Appeals of the Sixth District. The suit in question was brought against the city of Owosso, Mich., by Warren Bros. Co., of Boston, Mass., on account of alleged infringement of U. S. Patent No. 727,505, granted on May 5, 1903, to the late Frederick T. Warren for what has since become known as bitulithic pavement. The suit was defended by the Barber Asphalt Paving Co., which constructed the pavement in question. The higher court reversed the decision of the lower court and ordered an accounting for damages. Extracts from the decision follow:

The invention relates to an improvement in that class of street pavements consisting of a foundation of mineral matter and a top surfacing, or wearing surface, made of graded mineral matter intimately associated and united by means of asphalt or coal tar. The inventor claims as his discovery that the best conditions of this top or surface of a mineral roadbed is that this top or wearing surface of such pavements

must be made as dense, as free from voids, as possible, and also stable and non-liable to displacement.

Under the art, as practiced theretofore, the inventor says that the mineral matter united by plastic material has generally been fine gravel or sand or broken stone, not exceeding pieces of stone or other ground material above one-tenth of an inch in diameter. That the smallest percentage of voids under that method was 21% of the aggregate. He declares that to secure stability there mus. be a departure from this method, and that by the employment of larger sized pieces,

say up to those which will pass through a 2-in. ring and employing with these larger grains proper quantities of the smaller sizes down to an impalpable powder, it is possible to reduce the voids of the mineral base below 10% of its bulk.

Such an assemblage, he says, compacted together will form a dense, solid, homogeneous, compact body with the smallest percentage of voids and possessing the highest degree of stability and one in which the largest and smallest pieces are associated with each other indiscriminately throughout the structure and one which, because of the sizes of the pieces and their arrangement with respect to each other, offers the smallest areas of surface for the attachment of the plastic composition to them, so that not only is a superior binding effected, or union obtained by the plastic composition, but a smaller quantity of it is necessary for the purpose of obtaining the superior result or product. The specifications lay stress upon the fact that the stone components of different sizes are not to be used in layers of corresponding sizes, but mixed together, the large, the small and the dust in one aggregate, with the asphalt or other plastic composition permeating the whole mass and uniting the particles by filling in the voids and making a solid surface. This composition is spread uniformly over the top of a roadbed foundation, preferably of macadam, and is intended to form only the top or wearing surface of such a roadbed.

The mixture preferred by the inventor is described by the inventor in his specifications as follows:

I prefer to use from 1 to 3% of impalpable powder, from 10 to 30% of material between impalpable powder and ¼-in. in size, and from 50 to 80% of material larger than ¼-in. in size. I have found that these ingredients when associated together produce a mass or body having less than 20% of voids. I prefer to use as the uniting or plastic composition one which comprises asphalt and an oil flux heated to a moderate heat to provide the requisite fluidity; but I do not confine myself to any special form of artificial or natural asphalt.

Among the advantages claimed in the patent specifications are:

(1) That the percentage of mineral matter employed is increased and that of the bitumen decreased, thereby cheapening the cost; (2) that the wearing qualities of the pavement are much increased, due to the fact that "a very rigid and stable effect is obtained which reduces strain and wear upon the uniting medium, more of the wear being borne by the mineral base and less by the uniting medium"; (3) the reduction of voids formed by the mineral constituents, in that they are larger and fewer, the plastic fluid filling such spaces with a cellular structure, which, it is claimed, adheres better to the surface of the stone pieces than when the interstices of the composition are smaller and more numerous.

The claims in issue are the 5th, 6th, 9th and 11th, and are as follows:

5. In a street pavement, a bituminous mineral structure the mineral ingredients of which are fixed and of several grades, so graded as to give the structure an inherent stability.

6. A bituminous street pavement structure containing mixed mineral ingredients of such grades as to give the structure an inherent stability.

* * * * * * * *

9. A street pavement wearing section composed of a mineral structure of inherent stability formed of several grades of material so proportioned as to have a per cent. of voids less than 20% of the whole, in combination with a comparatively soft bituminous binder filling said voids and rendering the whole permanent in nature and elastic and waterproof in character.

* * * * * * * * *

11. A street paving structure composed of a mixture of mineral or wearing ingredients and a plastic binder, the space between the mineral ingredients being less than 21% of the whole, and the plastic binder occupying said space.

[Lurton, Circuit Judge, after making the foregoing statement of the case, delivered the opinion of the court.]

The street pavement of the Warren patent is plainly differentiated from the pavement structures in practical use before his invention and no serious effort has been made to show its anticipation by any of the known and practical methods of making roadways.

After reviewing the anticipations of the patent alleged as having been made by the defendant company, including a sidewalk and a shed floor or driveway at one of the buildings of the company on Long Island, and characterizing all these as experiments, the decision continues:

Experiments which did not in six years result in any change in the company's sand and asphalt mixture, as applied to either sidewalk or street pavements, can but be regarded as unsuccessful. When Warren had demonstrated the great value of the bitulithic pavement and competition with that mode of construction arose, the asphalt company reverted to this old bit of sidewalk as an anticipation which would enable them to defy Warren's patents.

* * * They were a series of experiments intended to discover other uses for asphalt, but not one of these went into public use. Aside from the sidewalk referred to, not one of them had any relation to the difficult problem of roadways and did not teach the public anything of value in that direction.

* * * * * * * * *

The presumption that he (Warren) believed himself to be the inventor of the pavement, for which he was given a patent, must be our starting point in determining whether his patent is defeated by anticipation. That somebody had in fact made the same composition before he did, does not necessarily defeat his patent. In one sense, he would not be the first inventor in such case. But in the sense of the patent statute, he is the first inventor, who, by his own thought, makes an article or material, and first perfects and adapts his discovery to actual use, although some one may have previously made a similar article, without putting it to practical use or giving his discovery to the public in any way.

We are the more indisposed to treat this piece of experimental sidewalk as an anticipation because, in the wide range which has been covered by the evidence in this case, it has not been shown that anywhere had there been constructed a single rod of street pavement according to his plan prior to his invention. Under such circumstances, we cannot think the proof of anticipation strong enough to deprive him of his invention.

The patents relied upon as anticipations need little notice and have received little attention in briefs or arguments. Those most worthy of attention are the Van Camp and Clark provisional English specification and the British patents to Ward. They are both lamentably lacking in instruction as to the proportions of mineral ingredients of the different grades. They do propose the use of large stones and smaller ones to fill the voids together with asphalt or tar. But they do not disclose Warren's basic idea of using the several grades of stones so graded as that the stone aggregate will of itself have inherent stability, which will relieve in large part the burden and strain upon the bitumen binder. Warren gives clear directions as to the construction and clearly discloses the factor of stability resulting from properly grading the mineral ingredients in excess of that found in the greater density of the sand and asphalt concrete.

To overthrow a patent by a foreign one of prior date the description of the invention must be in such full, clear and exact terms as to enable one acquainted with the art to which it belongs to make, construct and practice the invention. Mere vague and general representations in a foreign patent will not support the defense of anticipation.

A fatal objection to the Ward English patents is found in the fact that printed copies were not on sale prior to the actual date of Warren's invention which is clearly shown to have been made not later than Jan. 4, 1900; the Warren [Ward?] patents were not published prior to October of 1900.

The fifth, sixth and eleventh claims are infringed. The ninth is not, as it is not shown that the defendants below employed the "comparatively soft bitumen binder" made an element of that claim.

Annual Meeting of the American Society of Civil Engineers.

The American Society of Civil Engineers held its annual meeting at its house, 220 West 57th St., New York City, on Jan. 20 and 21, 1909. The business proceedings occupied only a single hour, everything being disposed of smoothly and without discussion. The remaining time was used for two inspection trips, and the annual reception and a smoker, where time passed pleasantly in social intercourse. The first of the inspection trips was made on Wednesday afternoon, Jan. 20, and consisted of an automobile tour over the new Blackwell's Island Bridge and returning by way of the Williamsburgh Bridge, to the new transatlantic steamship piers in the Chelsea section (described in our issue of Jan. 14, 1909). The other was an all-day trip to the site of the Ashokan Reservoir, the new source of water supply of New York City.

The work of the business session contained some rather important items, but as it was gone through in rapid routine fashion only the formal action taken can be reported.

NOMINATING COMMITTEE.—On the basis of the preliminary straw vote by mail, in the several districts, the meeting selected as members of the nominating committee the gentlemen named below. In every case but one the election went to the man having the highest straw vote. The results by districts are: (1) Frederick W. Gardiner, New York City; (2) Richard A. Hale, Lawrence, Mass.; (3) Edward B. Codwise, Kingston, N. Y.; (4) Frank Sutton, Washington, D. C.; (5) Henry E. Riggs, Toledo, O.; (6) Charles C. Wentworth, Roanoke, Va.; (7) Charles E. Fowler, Seattle, Wash.

The present method of selecting members of the Nominating Committee was later criticized by Mr. Samuel Whinery, by reference to the fact that in recent years only 7% of the corporate membership, on the average, took part in the preliminary vote, and that frequently as few as 5 votes, and once or twice but 2 votes, dictated the selection of a member of the committee. After developing at some length the defects of the existing method, Mr. Whinery moved that the Board of Direction (which has the duty of prescribing the method of choosing the members of the Nominating Committee) be requested to give further consideration to the matter and report its conclusions at the next annual convention of the society. The motion was carried.

CONSTITUTIONAL AMENDMENT.—Mr. Clemens Herschel's proposed amendment to the constitution, which the Denver convention last July referred to a special committee for consideration, aimed to retain the practice of referring membership election to letter-ballot of all corporate members, but proposed to reform the past conditions by requiring for rejection one-fifth of all votes cast, instead of 20 votes. The Denver convention amended it to require 1% of the corporate membership to exclude, and referred it to the committee in this form. Since then, however, the society has by letter-ballot finally adopted a rival amendment which places the election of new members wholly in the hands of the Board of Direction. It might be concluded that this action virtually means the rejection of Mr. Herschel's amendment; besides, in strict terms the latter is no longer applicable, since it quotes and amends passages of the old constitution which do not exist since the adoption of the other amendment. But the committee reports that it believes it would be dangerous to declare Mr. Herschel's amendment void on this technical ground, and therefore recommends that the secretary be instructed to rephrase the amendment so as to make it apply to the present form of the constitution, and thereupon send it out for vote by letter-ballot. It is the opinion of the committee, however, that the amendment should be defeated.

PRIZES.—The committee charged with recommending awards of the society's prizes for technical papers recommended to the Board of Direction the following awards: Norman Medal to C. C. Schneider, for his paper "Movable Bridges"; the Rowland Prize to E. E. Wall, for his paper "Water Purification at St. Louis"; [illegible] the Collingwood Prize for Juniors to D. [illegible] Krellwitz, for his paper "Reinforced-Concrete [illegible] Towers." These awards were confirmed by the Board, which also, at the request of the committee, expressed to the San Francisco engineers who contributed papers on the California earthquake of 1906 its appreciation of their work.

OFFICERS.—The count of ballots for officers for the coming year showed the election of the following:

President, Onward Bates, of Chicago, Ill.; Vice-Presidents, George H. Pegram, of New York City, and Emil Swensson, of Pittsburg, Pa.; Treasurer, Joseph M. Knap, of New York City; Directors, Francis L. Stuart, of New York City, Samuel C. Thompson, of New York City, William G. Wilkins, of Pittsburg, Pa., Arthur N. Talbot, of Urbana, Ill., William M. [illegible]ardner, of Memphis, Tenn., and Horace A. Sum[illegible], of Denver, Colo.

SUMMER CONVENTION.—It was announced that the next annual convention will be held at the Mount Washington Hotel, Bretton Woods, N. H., on July 6 to 9, 1909.

Committee Reports.

METRIC SYSTEM.—A committee of two members (S. B. Opdyke, Jr., and D. Molitor) on the status of the metric system of weights and measures presented a report urging prompt action by State legislatures and by Congress to establish the metric system in the United States. The report contains no new matter or arguments, unless the first sentence of the following paragraph be considered new:

Antagonistic public opinion has been brought about by unwarranted efforts on the part of some manufacturers who believe that their immediate pecuniary interests might suffer. Here, again, the lack of understanding prompts action which is distinctly harmful to the future welfare and prosperity of the nation. Such shortsightedness results not only in a future pecuniary loss, but retards the general progress of the world.

A written discussion traversing the arguments of the report was presented by Mr. H. R. Towne, who may possibly be one of the short-sighted manufacturers that lack understanding to whom the above paragraph refers.

ENGINEERING EDUCATION.—A brief report by Mr. Desmond FitzGerald stated that a joint committee had been formed of committees of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, the American Institute of Electrical Engineers, the American Chemical Society, and the General Education Board of the Carnegie Foundation, each contributing body having two members in the joint committee. The joint committee has already organized; it has elected Mr. FitzGerald its chairman.

STEEL COLUMN TESTS.—This committee, under the chairmanship of Mr. A. L. Bowman, with Mr. L. D. Rights as secretary, is required to "consider and report upon the design, ultimate strength and safe working values of steel columns and struts." It brought in a preliminary report which says that tests of large columns are badly needed, but that no testing-machine large enough for the purpose exists at present. The cost of building such a machine and conducting tests is far too great for any private parties, however, and it is therefore urged that the National Government undertake the work. The resolution says, in part, that whereas,

building a machine capable of testing to destruction full-size compression members of large dimensions and of accurately recording results is beyond the means of private interests, and can best be undertaken by the United States Government,

Resolved, that the United States Government be hereby requested to make a sufficient appropriation for and proceed with the construction of a testing-machine which will accomplish the desired results.

The resolution was adopted by the meeting.

RAIL SECTIONS.—The Committee on Rail Sections, of which Mr. J. T. Richards is chairman and Mr. R. W. Hunt, secretary, reported that its recommendations of a year ago (Eng. News, Jan. 23, 1908, p. 105), containing principles on which the design of rail sections should be based, have been widely accepted as a guide. To go further than this and report actual rail sections, says the committee, is not

yet possible [illegible] no similar organization in the country would undertake to design a standard rail section today. The committee directs attention to the increased use of open-hearth steel rails, and to increased facilities for getting rails of this material in the future.

CONCRETE AND REINFORCED CONCRETE.—The society's representatives on the famous Joint Committee on Concrete and Reinforced Concrete brought before the meeting what they called a "progress report." While the fact is not stated in the report, this document was worked out by the entire Joint Committee and has been adopted by it. It therefore comes before the world as the first tangible result of the four years' labors of the bulky and influential Joint Committee, a body made up of representatives from this society, the American Railway Engineering & Maintenance of Way Association, the American Society for Testing Materials, and the Association of American Portland Cement Manufacturers (the latter a commercial organization).

It has been known that very extensive testing has been carried on under the direction of the Joint Committee for some three years past. Naturally, therefore, one would look for a statement of progress, plans and present results in the committee's first "progress report." Nothing of the kind appears in the report, and the almost ridiculous fact is that the report gives no hint that tests have been made or are in progress, and says nothing whatever as to the nature of the further work which the committee believes it should do.

The report is an elementary didactic disquisition on the nature, uses and limitations of concrete, supplemented by (1) recommendations as to stresses, (2) advocacy of the commonly used assumptions that concrete in a beam has zero tensile strength, that the stresses in a beam are distributed over the section according to a straight-line law, etc., and (3) citation of the formulas applicable to beam design on the basis of these assumptions. It would be impossible to quote any part of the report as representing the tenor of the whole, but the following notes as to specified stresses and related matters may be extracted:

Concrete is credited with a compressive strength of 2,000 lbs. per sq. in. at 28 days; when in a specific piece of work the tests show higher average results, the unit-stresses named below may be increased, up to 25%. The values recommended for 2,000-lb. concrete are: Compression in beams, 650 lbs. per sq. in. at center and 750 lbs. per sq. in. near supports where beams are continuous over supports. Bearing compression, 650 lbs. per sq. in. Axial compression, 450 lbs. per sq. in. Shear, 120 lbs. per sq. in. Diagonal shear in beams, 325 lbs. per sq. in. Diagonal tension, 40 lbs. per sq. in. Bond stress, 80 lbs. for plain bars and 40 lbs. per sq. in. for drawn wire. Ratio of moduli of elasticity, 15. Stress in steel, 16,000 lbs. per sq. in. Effective area in case of hooped columns equals area within hooping; in other members, gross area less 1-in. fireproofing thickness in slabs or 1½ to 2 ins. in beams and columns. Width of slab which may be considered as part of beam as a T-beam, not over one-fourth the span length of beam, and overhang of width on either side not over four times thickness of slab. Bending moment in slabs, $wl^2/12$ both at center and at ends. Bending moment in beams, $wl^2/12$ for interior spans and $wl^2/10$ for end spans. Column stress, in case of longitudinal reinforcement only, 450 lbs. per sq. in.; in case of hooping, 540 lbs. per sq. in.; in case of hooping with 1 to 4% longitudinal reinforcement, 650 lbs. per sq. in.; in case of structural steel reinforcement, 650 lbs. per sq. in.; but the longitudinal reinforcement is to be credited further with its proportion of the load on the basis of the relative moduli of elasticity, whereas hooping or banding (which should be at least 1% in volume) is to be given no further allowance than in the higher concrete stress, above specified.

The specifications for cement adopted by the American Society for Testing Materials are attached to the report and are recommended.

This report was signed by six of the ten members of the American Society of Civil Engineers' committee. Four members declined to join in the report, and state their reasons in a minority report. A few passages may be given to indicate the nature of these reasons:

We do not consider the report as presented to be in proper shape for a document to be submitted to a society composed of engineers. As we understand the duty of your committee to be "to investigate and report," we are of the opinion that the report should consist of a dissertation on our investigations, with the conclusions derived therefrom. * * *

The chapter on design is limited to a description of minor details of a particular kind of construction, generally, and sometimes improperly, used in reinforced-concrete work of buildings, to the exclusion of other types. * * *

The working strains on concrete, as recommended, are arbitrarily assumed, without reference to any tests, or facts established by experience. * * *

No recognized theory for computing the internal forces in reinforced concrete is in existence at the present time. * * * The number of disasters in concrete structures has not diminished but rather increased; a word of warning, therefore, would be appropriate at this time.

We are of the opinion that the acceptance of the report in its present shape would have a tendency to encourage questionable practice, which is not in harmony with the aims and objects of this society.

The reports were received by the meeting and the committee was continued. Mr. R. L. Humphrey, in presenting the majority report, said that the sole object of the committee in submitting it was to get it into print and subject it to discussion by the members of the society. However, in view of the action of the Joint Committee in adopting it, the actual effect of the report is likely to overshoot this modest mark.

Report of the National Conservation Commission and Accompanying Message of President Roosevelt.

The report of the National Conservation Commission, which was submitted to Congress on Jan. 22 with a special message from President Roosevelt, is largely of the nature of a grand inventory of the natural resources of the country. A few recommendations were submitted by the Commission, but for the most part specific recommendations were left to be made by the President. This he did in his able and interesting special message. The chief recommendation by the President was an endorsement of a resolution adopted by the conference between the National Conservation Commission, the governors of states, state conservation commissions, and committees of citizens' organizations, held in Washington last December. This resolution urged a permanent "national commission on the conservation of the resources of the country, with power to cooperate with state commissions" on state resources. President Roosevelt suggests that an appropriation of at least $50,000 be made to cover the expenses of the National Conservation Commission.

The report of the National Conservation Commission was transmitted to the President by Mr. Gifford Pinchot, Chairman. In his letter of transmittal Mr. Pinchot stated that the inventory of natural resources was begun on July 1, 1908, with the cooperation of various federal bureaus, state authorities, and "representative bodies of the national industries." The vast amount of material collected was put in the hands of Mr. Henry Gannett for collation and summary.

One of the objects of the National Conservation Commission was to cooperate "with other bodies created for similar purposes by the states." On Jan. 11, 1909, commissions had been formed by 36 states and territories, and it appeared probable that nearly all the remaining states would soon take like action. On the same date no less than 41 national organizations had appointed conservation commissions to deal with the report.

Report of the National Conservation Commission.

The report of the Commission opens with the following significant sentence:

The duty of man to man, on which the integrity of nations must rest, is no higher than the duty of each generation to the next; and the obligation of the nation to each actual citizen is no more sacred than the obligation to the citizen to be, who, in turn, must bear the nation's duties and responsibilities.

After a few paragraphs reviewing in a general way the uses which have been made of the natural resources of the country since its settlement, the development of our natural resources is divided into "three noteworthy stages," as follows:

The first stage was that of individual enterprise for personal and family benefit. It led to the conquest of the wilderness.

The next stage was that of collective enterprise, either for the benefit of communities or for the profit of individuals forming the communities. It led to the development of cities and states, and too often to the growth of great monopolies.

The third stage is the one we are now entering. Within it the enterprise is collective and largely cooperative, and should be directed toward the larger benefit of communities, states and the people generally.

In the first stage the resources received little thought. In the second they were wastefully used. In the stage which we are entering wise and beneficial uses are essential, and the checking of waste is absolutely demanded.

Lands and forests are characterized as "improvable resources," and minerals as "expendable resources." Fresh waters are "a naturally renewable resource," which, though limited in quantity, may be conserved and the utilization of which may be bettered.

The most reprehensible of all waste is destruction, "as in forest fires, uncontrolled flow of gas and oil, soil wash, and abandonment of coal in the mines." The "ignorance, indifference or false notions of economy" to which these wastes are attributable should be rectified by the people as a whole.

Misuse of natural resources, like burning fuel in poor furnaces and loss of flood waters, is likewise reprehensible and may be remedied. Less reprehensible is "waste arising from non-use."

The most effective means for prevention of waste "will be found in the increase and diffusion of knowledge." The people themselves "may prevent or limit the destruction of resources and restrain misuse through the enactment and enforcement of appropriate state and federal laws."

The balance of the report, which consists of the inventory of natural resources, together with some concluding remarks, may be quoted in full as follows:

Minerals.

The mineral production of the United States for 1907 exceeded $2,000,000,000, and contributed 65% of the total freight traffic of the country. The waste in the extraction and treatment of mineral products during the same year was equivalent to more than $300,000,000.

The production for 1907 included 395,000,000 tons of bituminous and 85,000,000 tons of anthracite coal, 166,000,000 bbls. of petroleum, 45,000,000 tons of high-grade and 11,000,000 tons of low-grade iron ore, 2,500,000 tons of phosphate rock, and 869,000,000 lbs. of copper. The values of other mineral products during the same year included clay products, $162,000,000; stone, $71,000,000; cement, $56,000,000; natural gas, $50,000,000; gold, $90,000,000; silver, $37,000,000; lead, $39,000,000, and zinc, $26,000,000.

The available and easily accessible supplies of coal in the United States aggregate approximately 1,400,000,000,000 tons. At the present increasing rate of production this supply will be so depleted as to approach exhaustion before the middle of the next century.

The known supply of high-grade iron ores in the United States approximates 3,840,000,000 tons, which at the present increasing rate of consumption can not be expected to last beyond the middle of the present century. In addition to this, there are assumed to be 59,000,000,000 tons of lower grade iron ores which are not available for use under existing conditions.

The supply of stone, clay, cement, lime, sand, and salt is ample, while the stock of the precious metals and of copper, lead, zinc, sulphur, asphalt, graphite, quicksilver, mica, and the rare metals can not well be estimated, but is clearly exhaustible within one to three centuries unless unexpected deposits be found.

The known supply of petroleum is estimated at 15,000,000,000 to 20,000,000,000 bbls., distributed through six separate fields having an aggregate area of 8,900 sq. mi. The production is rapidly increasing, while the wastes and the loss through misuse are enormous. The supply can not be expected to last beyond the middle of the present century.

The known natural-gas fields aggregate an area of 9,000 sq. mi., distributed through 22 states. Of the total yield from these fields during 1907, 400,000,000,000 cu. ft., valued at $62,000,000, were utilized, while an equal quantity was allowed to escape into the air. The daily waste of natural gas—the most perfect known fuel—is over 1,000,000,000 cu. ft., or enough to supply every city in the United States of over 100,000 population.

Phosphate rock, used for fertilizer, represents the slow accumulation of organic matter during past ages. In most countries it is scrupulously preserved; in this country it is extensively exported, and largely for this

reason its production is increasing rapidly. The original supply can not long withstand the increasing demand.

The consumption of nearly all our mineral products is increasing far more rapidly than our population. In many cases the waste is increasing more rapidly than the number of our people. In 1776 but a few dozen pounds of iron were in use by the average family; now our annual consumption is over 1,200 lbs. per capita. In 1812 no coal was used; now the consumption is over 5 tons and the waste nearly 3 tons per capita.

While the production of coal is increasing enormously, the waste and loss in mining are diminishing. At the beginning of our mineral development the coal abandoned in the mine was two or three times the amount taken out and used. Now the mine waste averages little more than half the amount saved. The chief waste is in imperfect combustion in furnaces and fire boxes. Steam engines utilize on the average about 8% of the thermal energy of the coal. Internal-combustion engines utilize less than 20%, and in electric lighting far less than 1% of the thermal energy is rendered available.

With increasing industries new mineral resources become available from time to time. Some lignites and other low-grade coals are readily gasified and, through the development of internal-combustion engines, check the consumption of high-grade coals. Peat is becoming important; it is estimated that 14,000,000,000 tons are available in the United States. Its value is enhanced because of distribution through states generally remote from the fields of coal, oil and natural gas.

The uses of all our mineral resources are interdependent. This is especially true of coal and iron, of which neither can be produced or used without aid from the other, and in the production or reduction of all other minerals, both coal and iron are employed. The same standard minerals are necessary to the development of power, of which the use is increasing more rapidly than that of any other commodity.

The building operations of the country now aggregate about $1,000,000,000 per year. The direct and indirect losses from fire in the United States during 1907 approximated $450,000,000, or one-half the cost of construction. Of this loss four-fifths, or an average of $1,000,000 per day, could be prevented, as shown by comparison with the standards of construction and fire losses in the larger European countries.

So far as the ores are taken from the mines and reduced to metals, these resources are capitalized; but after thus being changed to a more valuable form they should be so used as to reduce to a minimum the loss by rust, electrolytic action, and other waste.

There is urgent need for greater safety to the miner. The loss of life through mine accidents is appalling, and preventive measures can not be taken too soon.

The National Government should exercise such control of the mineral fuels and phosphate rocks now in its possession as to check waste and prolong our supply.

While the distribution and quantity of most of our important mineral substances are known in a general way, there is imperative need for further surveys and investigations and for researches concerning the less-known minerals.

Lands.

The total land area of continental United States is 1,900,000,000 acres. Of this but little more than two-fifths is in farms, and less than one-half of the farm area is improved and made a source of crop production. We have nearly 6,000,000 farms; they average 146 acres each. The value of the farms is nearly one-fourth the wealth of the United States. There are more than 300,000,000 acres of public grazing land. The number of persons engaged in agricultural pursuits is more than 10,000,000.

We grow one-fifth of the world's wheat crop, three-fifths of its cotton crop, and four-fifths of its corn crop. We plant nearly 50,000,000 acres of wheat annually, with an average yield of about 14 bu. per acre; 100,000,000 acres of corn, yielding an average of 25 bu. per acre; and 30,000,000 acres of cotton, yielding about 12,000,000 bales.

We had on Jan. 1, 1908, 71,000,000 cattle, worth $1,250,000,000; 54,000,000 sheep, worth $211,000,000; and 56,000,000 swine, worth $339,000,000. The census of 1900 showed $137,000,000 worth of poultry in this country, which produced in 1899 293,000,000 dozen eggs.

There has been a slight increase in the average yield of our great staple farm products, but neither the increase in acreage nor the yield per acre has kept pace with our increase in population. Within a century we shall probably have to feed three times as many people as now; and the main bulk of our food supply must be grown on our own soil.

The area of cultivated land may possibly be doubled. In addition to the land awaiting the plow, 75,000,000 acres of swamp land can be reclaimed, 40,000,000 acres of desert land irrigated, and millions of acres of brush and wooded land cleared. Our population will increase continuously, but there is a definite limit to the increase of our cultivated acreage. Hence we must greatly increase the yield per acre. The average yield of wheat in the United States is less than 14 bu. per acre, in Germany 28 bu., and in England 32 bu. We get 30 bu. of oats per acre, England nearly 45, and Germany more than 47. Our soils are fertile, but our mode of farming neither conserves the soil nor secures full crop returns. Soil fertility need not be diminished, but may be increased. The large yields now obtained from farms in Europe which have been cultivated for a thousand years prove this conclusively. Proper management will double our average yield per acre. The United States can grow the farm products needed by a population more than three times as great as our country now contains.

The greatest unnecessary loss of our soil is preventable erosion. Second only to this is the waste, nonuse and misuse of fertilizer derived from animals and men.

The losses to farm products due to injurious mammals is estimated at $130,000,000 annually; the loss through plant diseases reaches several hundred million dollars; and the loss through insects is reckoned at $659,000,000. The damage by birds is balanced by their beneficent work in destroying noxious insects. Losses due to the elements are large, but no estimate has been made of them. Losses to live stock from these causes are diminishing because of protection and feeding during winter. The annual losses from disease among domestic animals are: Horses, 1.8%; cattle, 2%; sheep, 2.2%; and swine, 5.1%. Most of these farm losses are preventable.

There is a tendency toward consolidation of farm lands. The estimated area of abandoned farms is 16,000 sq. mi., or about 3% of the improved land. The causes of abandonment differ in different parts of the country. Where most prevalent, it is caused principally by erosion and exhaustion of the soil.

The product of the fisheries of the United States has an annual value of $57,000,000. Fish culture is carried on by the nation and the States on an enormous scale. Most of the more important food species are propagated, and several species are maintained in that way. Fish from forest waters furnish $21,000,000 worth of food yearly, a supply dependent on the preservation of the forests.

Our wild game and fur-bearing animals have been largely exterminated. To prevent their complete extinction the States and the United States have taken in hand their protection, and their numbers are now increasing. Forest game yields over $10,000,000 worth of food each year.

With game birds the story is much the same—wanton destruction until the number has been greatly reduced, followed in recent years by wise protection, which in some cases allows the remnant to survive and even to increase.

Each citizen of the United States owns an equal undivided interest in about 375,000,000 acres of public lands, exclusive of Alaska and the insular possessions. Besides this there are about 235,000,000 acres of national forests, national parks, and other lands devoted to public use.

Good business sense demands that a definite land policy be formulated. The National Conservation Commission believes that the following will serve as a basis therefor:

(1) Every part of the public lands should be devoted to the use which will best subserve the interests of the whole people.

(2) The classification of all public lands is necessary for their administration in the interests of the people.

(3) The timber, the minerals, and the surface of the public lands should be disposed of separately.

(4) Public lands more valuable for conserving water supply, timber, and natural beauties or wonders than for agriculture should be held for the use of the people from all except mineral entry.

(5) Title to the surface of the remaining non-mineral public lands should be granted only to actual home makers.

(6) Pending the transfer of title to the remaining public lands they should be administered by the Government and their use should be allowed in a way to prevent or control waste and monopoly.

The present public land laws as a whole do not subserve the best interests of the nation. They should be modified so far as may be required to bring them into conformity with the forgoing outline of policy.

Forests.

Next to our need of food and water comes our need of timber. Our industries which subsist wholly or mainly upon wood pay the wages of more than 1,500,000 men and women. Forests not only grow timber, but they hold the soil and they conserve the streams. They abate the wind and give protection from excessive heat and cold. Woodlands make for the fiber, health, and happiness of the citizen and the nation.

Our forests now cover 550,000,000 acres, or about one-fourth of the United States. The original forests covered not less than 850,000,000 acres. Forests publicly owned cover one-fourth of the total forest area and contain one-fifth of all our standing timber. Forests privately owned cover three-fourths of the area and contain four-fifths of the standing timber. The timber privately owned is not only four times that publicly owned, but is generally more valuable.

Forestry is now practiced on 70% of the forests publicly owned and on less than 1% of the forests privately owned, or on only 18% of the total area.

The yearly growth of wood in our forests does not average more than 12 cu. ft. per acre. This is a total yearly growth of less than 7,000,000,000 cu.

We have 200,000,000 acres of mature forest in which yearly growth is balanced by decay; 250,000,000 acres partly cut over or burned over, but restocking naturally with enough young growth to produce a merchantable crop, and 100,000,000 acres cut over and abandoned upon which young growth is lacking or scanty to make merchantable timber.

We take from our forests yearly, including waste in logging and in manufacture, 23,000,000,000 ft. of wood. We use each year 100,000,000 cords of firewood; 40,000,000,000 ft. of lumber; more than 1,000,000 posts, poles, and fence rails; 118,000,000 hewn ties; 1,500,000,000 staves; over 133,000,000 sets of heading; nearly 500,000,000 barrel hoops; 3,000,000 tons of native pulp wood; 165,000,000 cu. ft. of round mine timbers, and 1,250,000 cords of wood for distillation.

Since 1870 forest fires have destroyed a yearly average of 50 lives and $50,000,000 worth of timber. Not less than 50,000,000 acres of forest is burned over yearly. The young growth destroyed by fire is worth far more than the merchantable timber burned.

One-fourth of the standing timber is lost in logging. The boxing of long-leaf pine for turpentine has destroyed one-fifth of the forests worked. The loss in the mill is from one-third to two-thirds of the timber sawed. The loss of mill product in seasoning and fitting for use is from one-seventh to one-fourth. Of each 1,000 ft., which stood in the forest, an average of only 320 ft. of lumber is used.

We take from our forests each year, not counting the loss by fire, three and a half times their yearly growth. We take 40 cu. ft. per acre for each 12 cu. ft. grown; we take 260 cu. ft. per capita, while Germany uses 37 and France 25 cu. ft.

We tax our forests under the general property tax, a method abandoned long ago by every other great nation. Present tax laws prevent reforestation of cut-over land and the perpetuation of existing forests by use.

Great damage is done to standing timber by injurious forest insects. Much of this damage can be prevented at small expense.

To protect our farms from wind and to reforest land best suited for forest growth will require tree planting on an area larger than Pennsylvania, Ohio, and West Virginia combined. Lands so far successfully planted make a total area smaller than Rhode Island; and year by year, through careless cutting and fires, we lower the capacity of existing forests to produce their like again, or else totally destroy them.

In spite of substitutes we shall always need much wood. So far our use of it has steadily increased. The condition of the world's supply of timber makes us already dependent upon what we produce. We send out of our country one and a half times as much timber as we bring in. Except for finishing woods, relatively small in amount, we must grow our own supply or go without. Until we pay for our lumber what it costs to grow it, as well as what it costs to log and saw, the price will continue to rise.

The preservation by use, under the methods of practical forestry, of all public forest lands, either in state or federal ownership, is essential to the permanent public welfare. In many forest states the acquirement of additional forest lands as state forests is necessary to the best interests of the states themselves.

The conservation of our mountain forests, as in the Appalachian system, is a national necessity. These forests are required to aid in the regulation of streams used for navigation and other purposes. The conservation of these forests is impracticable through private enterprise alone, by any state alone, or by the Federal Government alone. Effective and immediate cooperation between these three agencies is essential. Federal ownership of limited protective areas upon important watersheds, effective state fire patrol, and the cooperation of private forest owners are all required.

The true remedy for unwise tax laws lies not in laxity in their application nor in special exemption, but in a change in the method of taxation. An annual tax upon the land itself, exclusive of the value of the timber, and a tax upon the timber when cut, is well adapted to actual conditions of forest investment, and is practicable and certain. It is far better that forest land should pay a moderate tax permanently than that it should pay an excessive revenue temporarily and then cease to pay at all.

Forests in private ownership cannot be conserved unless they are protected from fire. We need good fire laws, well enforced. Fire control is impossible without an adequate force of men whose sole duty is fire patrol during the dangerous season.

The conservative use of the forest and of timber by American citizens will not be general until they learn how to practice forestry. Through a vigorous national campaign in education, forestry has taken root in the

great bo[dy] ... American citizenship. The basis already exists upo[n] ... ich to build a structure of forest conservation whi[ch] ... ll endure. This needs the definite commitment ... tate governments and the Federal Government ... inherent duty of teaching the people how to care ... their forests. The final responsibility both for inv[en]tive work in forestry and for making its results k[no]wn ... ests upon the states and upon the nation.

By r[ea]sonable thrift, we can produce a constant timber su[p]ply beyond our present need, and with it conserve th[e] ... fulness of our streams for irrigation, water-supply, ... ation, and power.

Under ... t management, our forests will yield over four tim[es] ... as much as now. We can reduce waste in the woo[d] ... d in the mill at least one-third, with present as ... as future profit. We can perpetuate the naval s[to]res industry. Preservative treatment will reduce by ... -fifth the quantity of timber used in the water or ... the ground. We can practically stop forest fires at a ... cost yearly of one-fifth the value of the merchantable timber burned.

We shall suffer for timber to meet our needs until our forests have had time to grow again. But if we act vigorously, and at once, we shall escape permanent timber scarcity.

Waters.

The sole source of our fresh water is rainfall, including snow. From this source all running, standing, and ground waters are derived. The habitability of the country depends on these waters. Our mean annual rainfall is about 30 ins.; the quantity about 215,000,000,000,000 cu. ft. per year, equivalent to ten Mississippi Rivers.

Of the total rainfall, over half is evaporated; about a third flows into the sea; the remaining sixth is either consumed or absorbed. These portions are sometimes called, respectively, the fly-off, the run-off, and the cut-off. They are partly interchangeable. About a third of the run-off, or a tenth of the entire rainfall, passes through the Mississippi. The run-off is increasing with deforestation and cultivation.

Of the 70,000,000,000,000 cu. ft. annually flowing into the sea, less than 1% is restrained and utilized for municipal and community supply; less than 2% (or some 10% of that in the arid and semi-arid regions) is used for irrigation; perhaps 5% is used for navigation, and less than 5% for power.

For municipal and community water supply there are protected catchment areas aggregating over 600,000 acres, and over $250,000,000 are invested in water-works, with nearly as much more in the appurtenant catchment areas and other lands. The population so supplied approaches 10,000,000, and the annual consumption is about 37,500,000,000 cu. ft. [about 270,000,000,000 gals., or some 75 gals. per capita—Ed.] The better managed systems protect the catchment areas by forests and grass; the water is controlled and the storm product used, but there is large waste after the water enters the mains.

For irrigation it is estimated that there are $200,000,000 invested in dams, ditches, reservoirs, and other works for the partial control of the waters; and that 1,500,000,000,000 cu. ft. are annually diverted to irrigable lands, aggregating some 20,000 sq. mi. Except in some cases through forestry, few catchment areas are controlled, and few reservoirs are large enough to hold the storm waters. The waste in the public and private projects exceeds 60%, while no more than 25% of the water actually available for irrigation of the arid lands is restrained and diverted.

There are in continental United States 282 streams navigated for an aggregate of 26,115 miles, and as much more navigable if improved. There are also 45 canals, aggregating 2,189 miles, besides numerous abandoned canals. Except through forestry in recent years, together with a few reservoirs and canal locks and movable dams, there has been little effort to control headwaters or catchment areas in the interests of navigation, and none of our rivers are navigated to more than a small fraction even of their effective low-water capacity.

The water-power now in use is 5,250,000 HP.; the amount running over government dams and not used is about 1,400,000 HP.; the amount reasonably available equals or exceeds the entire mechanical power now in use, or enough to operate every mill, drive every spindle, propel every train and boat, and light every city, town and village in the country. While the utilization of water-power ranks among our most recent and most rapid industrial developments, little effort has been made to control catchment areas or storm waters in any large way for power, though most plants effect local control through reservoirs and other works. Nearly all the freshet and flood water runs to waste, and the low waters which limit the efficiency of power plants are increasing in frequency and duration with the increasing flood run-off.

The practical utility of streams for both navigation and power is measured by the effective low-water stage. The volume carried when the streams rise above this stage is largely wasted and often does serious damage. The direct yearly damage by floods since 1900 has increased steadily from $45,000,000 to over $238,000,000. The indirect loss through depreciation of property is great, while a large loss arises in impeded traffic through navigation and terminal transfers.

The freshets are attended by destructive soil erosion. The soil matter annually carried into lower rivers and harbors or into the sea is computed at 780,000,000 tons. Soil wash reduces by 10 or 20% the productivity of upland farms and increases channel cutting and bar building in the rivers. The annual loss to the farms alone is fully $500,000,000, and large losses follow the fouling of the waters and the diminished navigability of the streams.

Through imperfect control of the running waters lowlands are temporarily or permanently flooded. It is estimated that there are in mainland United States about 75,000,000 acres of overflow and swamp lands requiring drainage; that by systematic operation these can be drained at moderate expense, and that they would then be worth two or three times the present value and cost of drainage, and would furnish homes for 10,000,000 people.

It is estimated that the quantity of fresh water stored in lakes and ponds (including the American portion of the Great Lakes) is about 600,000,000,000,000 cu. ft., equivalent to three years' rainfall or eight years' run-off. Some 6,000,000 of our people draw their water supply from lakes.

A large part of that half of the annual rainfall not evaporated lodges temporarily in the soil and earth. It is estimated that the ground water to the depth of 100 ft. averages 16⅔% of the earth-volume or over 1,400,000,000,000,000 cu. ft., equivalent to seven years' rainfall or twenty years' run-off. This subsurface reservoir is the essential basis of agriculture and other industries and is the chief natural resource of the country. It sustains forests, and all other crops and supplies the perennial springs and streams and wells used by four-fifths of our population and nearly all our domestic animals. Its quantity is diminished by the increased run-off due to deforestation and injudicious farming. Although the volume of the available ground water is subject to control by suitable treatment of the surface, little effort has been made to retain or increase it, and it is probable that fully 10% of this rich resource has been wasted since settlement began. The water of the strata below 100 ft. supplies artesian and deep wells, large springs, and thermal and mineral waters. It can be controlled only through the subsurface reservoir.

Of the 35,000,000,000,000 cu. ft. of cut-off, the chief share is utilized by natural processes or by agriculture and related industries. On an average the plant tissue of annual growths is three-fourths and of perennial growths three-eighths water; of human and stock food over 80% is water, and in animal tissue the ratio is about the same; and since water is the medium for organic circulation, the plants and animals of the country yearly require an amount many times exceeding their aggregate volume. Even in the more humid sections of the country the productivity of the soil and the possible human population would be materially increased by a greater rainfall, leaving a larger margin for organic and other chemical uses. Except through agriculture and forestry little general effort is made to control the annual cut-off, although some farmers in arid regions claim to double or triple the crop from given soil by supplying water just when needed and withholding it when not required.

Water is like other resources in that its quantity is limited. It differs from such mineral resources as coal and iron, which once used are gone forever, in that the supply is perpetual, and it differs from such resources as soils and forests, which are capable of renewal or improvement, in that it cannot be augmented in quantity, though like all other resources it can be better utilized.

It is now recognized by statesmen and experts that navigation is interdependent with other uses of the streams; that each stream is essentially a unit from its source to the sea; and that the benefits of a comprehensive system of waterway improvement will extend to all the people in the several sections and states of the country.

It is also recognized, through the unanimous declaration of the governors of the states and territories adopted in conference with the leading jurists and statesmen and experts of the country, that in the use of the natural resources the independent states are interdependent, and bound together by ties of mutual benefits, responsibilities, and duties.

It has recently been declared by a majority of our leading statesmen that it is an imperative duty to enter upon a systematic improvement, on a large and comprehensive plan, just to all portions of the country, of the waterways and harbors and great lakes, whose natural adaptability to the increasing traffic of the land is one of the greatest gifts of a benign Providence, while the minority indorsed the movement for control of the waterways still more specifically and in equally emphatic terms.

Within recent months it has been recognized and demanded by the people, through many thousand delegates from all states assembled in convention in different sections of the country, that the waterways should and must be improved promptly and effectively as a means of maintaining national prosperity.

The first requisite for waterway improvement is the control of the waters in such manner as to reduce floods and regulate the regimen of the navigable rivers. The second requisite is development of terminals and connections in such manner as to regulate commerce.

In considering the uses and benefits to be derived from the waters, the paramount use should be water-supply; next should follow navigation in humid regions and irrigation in arid regions. The development of power on the navigable and source streams should be coordinated with the primary and secondary uses of the waters. Other things equal, the development of power should be encouraged, not only to reduce the drain on other resources, but because properly designed reservoirs and power plants retard the run-off and so aid in the control of the streams for navigation and other uses.

Broad plans should be adopted providing for a system of waterway improvement extending to all uses of the waters and benefits to be derived from their control, including the clarification of the water and abatement of floods for the benefit of navigation; the extension of irrigation; the development and application of power; the prevention of soil wash; the purification of streams for water supply; and the drainage and utilization of the waters of swamp and overflow lands.

To promote and perfect these plans scientific investigations, surveys, and measurements should be continued and extended, especially the more accurate determination of rainfall and evaporation, the investigation and measurement of ground water, the gaging of streams and determination of sediment, and topographic surveys of catchment areas and sites available for control of the waters for navigation and related purposes.

National Efficiency.

Since the greatest of our national assets is the health and vigor of the American people, our efficiency must depend on national vitality even more than on the resources of the minerals, lands, forests and waters.

The average length of human life in different countries varies from less than 25 to more than 50 years. This span of life is increasing wherever sanitary science and preventive medicine are applied. It may be greatly extended.

Our annual mortality from tuberculosis is about 150,000. Stopping three-fourths of the loss of life from this cause, and from typhoid and other prevalent and preventable diseases, would increase our average length of life over fifteen years.

There are constantly about 3,000,000 persons seriously ill in the United States, of whom 500,000 are consumptives. More than half this illness is preventable. If we count the value of each life lost at only $1,700 and reckon the average earning lost by illness as $700 per year for grown men, we find that the economic gain from mitigation of preventable disease in the United States would exceed $1,500,000,000 a year. In addition, we would decrease suffering and increase happiness and contentment among the people. This gain, or the lengthening and strengthening of life which it measures, can be secured through medical investigation and practice, school and factory hygiene, restriction of labor by women and children, the education of the people in both public and private hygiene, and through improving the efficiency of our health service, municipal, state, and national. The National Government has now several agencies exercising health functions which only need to be concentrated to become coordinated parts of a greater health service worthy of the nation.

The inventory of our natural resources made by your commission, with the vigorous aid of all federal agencies concerned, of many states, and of a great number of associated and individual cooperators, furnishes a safe basis for general conclusions as to what we have, what we use and waste, and what may be the possible saving. But for none of the great resources of the farm, the mine, the forest, and the stream do we yet possess knowledge definite or wide enough to insure methods of use which will best conserve them.

In order to conserve a natural resource, we must know what that resource is by taking stock of what we have. We greatly need a more complete inventory of our natural resources; and this cannot be made except through the active cooperation of the states with the nation.

The permanent welfare of the nation demands that its natural resources be conserved by proper use. To this end the states and the nation can do much by legislation and example. By far the greater part of these resources is in private hands. Private ownership of natural resources is a public trust; they should be administered in the interests of the people as a whole. The states and nation should lead rather than follow in the conservative and efficient use of property under their immediate control. But their first duty is to gather and distribute a knowledge of our natural resources and of the means necessary to insure their use and conservation, to impress the body of the people with the great importance of the duty, and to promote the cooperation

of all. No agency, state, federal, corporate, or private can do the work alone.

Finally, the conservation of our resources is an immediate and vital concern. Our welfare depends on conservation. The pressing need is for a general plan under which citizens, states, and nation may unite in an effort to achieve this great end. The lack of cooperation between the states themselves, between the states and the nation, and between the agencies of the National Government, is a potent cause of the neglect of conservation among the people. An organization through which all agencies, state, national, municipal, associate and individual, may unite in a common effort to conserve the foundations of our prosperity is indispensable to the welfare and progress of the nation. To that end the immediate creation of a national agency is essential. Many states and associations of citizens have taken action by the appointment of permanent conservation commissions. It remains for the nation to do likewise, in order that the states and the nation, associations and individuals, may join in the accomplishment of this great purpose.

Accompanying this report, and transmitted as a part thereof, are detailed statements by the secretaries of the several sections, and many papers and illustrations prepared by experts at the request of your commission [not yet made public.—Ed.]

Gifford Pinchot, Chairman.
W. J. McGee,
Secretary, Section of Waters.
Attest: Overton W. Price,
Thomas B. Shipp, Secretary, Section of Forests.
Secretary to George W. Woodruff,
the Commission. Secretary, Section of Lands.
December 7, 1908. J. A. Holmes,
Secretary, Section of Minerals.

President Roosevelt's Message.

The message of transmittal sent to Congress with the report of the Commission consisted in considerable part of a summary of the report of the Commission itself, and it also included some characteristic and pertinent expressions of opinion by the President. The report as a whole is characterized by President Roosevelt as

one of the most fundamentally important documents ever laid before the American people. It contains the first inventory of its natural resources ever made by any nation. . . . The facts set forth in this report constitute an imperative call to action.

Attention is called to the fact that our population is increasing by 20% every ten years, and it is stated that by 1950 we may have a population of 150,000,000, which "must be fed and clothed from the products of our soil." Although our rivers can and should be effective means of transportation, the vast expenditures which the nation has thus far incurred "for our waterways have not resulted in maintaining, much less in promoting, inland navigation." The President therefore urges that immediate steps be taken

to prepare and adopt a comprehensive plan for inland-waterway navigation that will result in giving the people the benefits for which they have paid but which they have not yet received.

Conservation is declared to be "the great fundamental basis for national efficiency"; and national efficiency is defined as

the result of natural resources well handled, of freedom of opportunity for every man, and of the inherent capacity, trained ability, knowledge and will, collectively and individually to use that opportunity.

The necessity for checking and controlling monopolies in the interests of the whole public is discussed in the well-known forceful manner of the President. The building of the Panama Canal is referred to as "the giant engineering feat of all time," and as an illustration of what the Government can do for its people.

The various recommendations of the Commission as to waterways, forests and lands are reviewed and endorsed by the President. In addition, he recommends the establishment of a bureau of mines in accordance with a bill now pending in Congress, to the end that both loss of life and waste of mineral resources may be lessened, and that the mineral supplies of the country may be conserved. In conclusion, the President recommends an appropriation for the continuance of the work of the Commission, as noted at the beginning of this article.

A NATIONAL TARIFF COMMISSION convention has been called by the National Association of Manufacturers and twenty other industrial and commercial organizations to meet at Indianapolis, Feb. 16 to 18. Delegates to the convention are to be named by commercial associations, Governors of states and Mayors of cities.

Annual Convention of the Wood Preservers' Association.

The fifth annual convention was held at the Auditorium Hotel, Chicago, on Jan. 19, 20 and 21. Owing to some unfortunate circumstances no program had been arranged and no papers prepared. A temporary committee was appointed, therefore, to prepare a list of subjects for discussion. As all these subjects were of direct practical interest to all present, there was no difficulty in starting the discussion, although the subjects were naturally treated in a somewhat discussive manner. The results were more satisfactory than might have been expected. While the proceedings are too voluminous to be abstracted in full in this place, some of its more important parts can be summarized briefly.

STATISTICS OF TIMBER TREATMENT.—Statistics have been prepared annually by Mr. C. W. Berry (Union Pacific Ry.), showing the annual amount of timber treated in this country by different processes and for different purposes. A summary of his tabulated results is given in the accompanying table.

THE PRESERVATIVE TREATMENT OF TIMBER IN THE UNITED STATES.

Process and material.	Amount of timber treated. 1907.	Increase or decrease* over 1906.	Ave. injection in 1907. lbs. per cu. ft.
(1) Creosote:			
Piling .....cu. ft.	6,024,169	665,342	13.00
Lumber .....cu. ft.	4,561,327	727,086	11.00
Bridge timber...cu. ft.	1,124,035	282,292	12.25
Switch ties.....cu. ft.	563,415	563,415	8.33
Paving blocks....cu. ft.	2,874,560	1,110,327	14.00
Cross arms.....cu. ft.	238,742	116,130	10.00
Net increase....cu. ft.	.....	3,444,592	.....
Ties .....No....	5,750,874	3,913,891	8.12
(2) Zinc chloride:			
Piling .....cu. ft.	.....	11,657*	.....
Lumber .....cu. ft.	74,564	290,847*	0.51
Bridge timber....cu. ft.	45,671	10,784	0.37
Switch ties.....cu. ft.	280,215	124,521*	0.35
Net decrease....cu. ft.	.....	416,241*	.....
Ties .....No....	9,864,765	4,304,019*	0.34
Piling .....cu. ft.	265,485	53,917	Zinc.
Lumber .....cu. ft.	9,456	3,765	0.25-lb.
Switch ties.....cu. ft.	47,356	47,356	Oil.
Net increase....cu. ft.	.....	105,038	3.00 lbs.
Ties .....No....	2,345,670	1,426,979	
(4) Zinc-glue-tannin:			
Ties .....No....	476,675	431,100*	0.50
(5) Summary; net increase over 1906:			
Piling		707,602 cu. ft.	
Lumber		440,004 cu. ft.	
Bridge timber		273,076 cu. ft.	
Switch ties		485,250 cu. ft.	
Paving blocks		1,110,327 cu. ft.	
Cross arms		116,130 cu. ft.	
Total (exclusive of cross ties).....		3,133,389 cu. ft.	
Ties		605,751 No....	

HISTORY OF WOOD PRESERVATION IN AMERICA.—This subject was presented by Mr. Octave Chanute, who stated that the present industry dates back to 1876 for piles and timbers, and to 1885 for ties. There had been earlier experiments. In 1881, the American Society of Civil Engineers appointed a committee to report upon the best methods of preserving timber in order to lengthen its life. The report was made in 1885. It showed that the first experiments in this line were made in 1838 on the Northern Central Ry. (from Baltimore to Elmira). Ties sufficient for a mile of track were treated by the Kyanising process (steeped in corrosive sublimate), but the cost was about 33 to 36 cts., and it was considered unnecessary to spend such an amount for treating ties that cost only 16 cts. In Europe, on the other hand, the scarcity of timber made it economical to spend 75 cts. to $1 per tie for treatment. The report showed that creosote was the best material, but would be very costly (a creosoting plant was built at West Pascagoula, La., in 1876, and is still in operation), and that the zinc process (or burnetising) would be more economical for ties, especially if some ingredient was added to prevent the zinc from washing out of the timber. The Atchison, Topeka & Santa Fe Ry. took this matter up, and in 1885 established a zinc-tannin plant at Las Vegas, N. M. The Union Pacific Ry. followed in 1886, and then the Chicago, Rock Island & Pacific Ry., but these latter plants were eventually abandoned for financial reasons. Since then the industry has grown until there are now about 60 plants, 50% operated by railways and the others by private companies.

Mr. Valentine referred to creosoted paving blocks treated by his father and in use at Galveston for over 20 years. Mr. Ca[illegible] spoke of the old bridge across Galveston [illegible] built in 1875. The contract called for 8 lb[illegible] creosote oil per cu. ft., but Mr. Valentine ([illegible] was connected with the works) considered [illegible]s insufficient, and treated some sticks with [illegible]ut 18 to 20 lbs. Some of these latter are [illegible] in use, while those having the lighter tre[illegible]nt lasted only about six or eight years. The [illegible]inder of the discussion related to more recent [illegible]tice and experience, and to the present meth[illegible] of treatment. Mr. Allerton remarked that [illegible]reosoting plant was erected near San Franc[illegible] by Mr. Dundon about 13 years ago, for piles [illegible]d timber.

THE TREATMENT OF HEARTW[illegible]D TIMBER.—Mr. Valentine stated that it [illegible]t possible to get very much creosote oil int[illegible] the heartwood of long-leaf yellow pine. The [illegible]netration would be about 3 ins. Mr. Allardyce [illegible]s obtained 3½ to 4 ins. penetration in long-leaf [illegible]ine piles. With stringers of the same heartwo[illegible] treated with 8 lbs. of creosote per cu. ft., the penetration was about ½-in. to ¾-in. For the [illegible]ling, the quantity was 15 to 16 lbs. of oil, and more than this would injure the wood. The timber must be steamed to secure this absorption.

Mr. Crawford thought that the heartwood of red oak and black gum can be successfully treated, the latter very easily. The heartwood of hickory, also, can be treated more easily than its sap wood. Heartwood ties of Douglas fir are very hard to treat, as they come from the center of the tree, where the heartwood is old and very dense. Mr. Chanute stated that in his experience, the water oak takes treatment better than the black oak, while the red oak is more difficult than the latter. Mr. Buehler referred to the treatment of Douglas fir timbers. They were originally 16 × 16 ins., but after being seasoned for a year they were cut to 8 × 16 ins. and treated. When removed from the cylinder, the fiber was found to be gone from the three old surfaces to a depth of as much as 1½ ins. in some places, while the new surface remained true. He attributed this to the removal of the moisture from the cells in the sides exposed in seasoning. For this reason, Douglas fir should be treated in its green state. Mr. Rex stated that he had experimented with the treatment of fir ties with Mexican residuum oil for 24 hours at 200° F. and 200 lbs. pressure. The result was that the ties were so badly deformed, split and shrunk both endways and sideways that they were useless.

THE TREATMENT OF DEAD TIMBER.—Mr. C. W. Berry (Union Pacific Ry) stated that dead timber is not desirable when obtained soon after it has been killed. The chloride of zinc solution will penetrate it more easily, but will leach out much sooner than out of live timber. Mr. Angier (C., B. & Q. Ry.) stated that the plant at Sheridan, Wyo., receives about 15,000 ties of dead timber per month. The timber is classed as "sorrel-top" (dead about one year), "red-top" (dead two years), and "black-top" (dead three years or more). The railway company buys ties of the first two classes, and when treated they make very good ties. In the "black-top" timber, however, decay has begun. In the treatment, a weak zinc solution is used, about 1½ to 2%, giving about ½-lb. of zinc per cu. ft. Mr. Buehler (Kettle River Quarries Co.) has had very little trouble in treating fire-killed timber in Oregon. Mr. Chanute stated that excellent ties can be made from dead timber, and that great quantities of such timber may be utilized. It is pointed out, however, that while the government is advocating the use of dead timber, in order to reduce the draft upon the standing timber, many railways refuse to use ties made from the dead timber.

THE INFLAMMABILITY OF TREATED TIMBER.—Mr. Rollins stated that timber treated by the burnetising process is to a certain extent fireproof. For trestles of creosoted timber, a ballasted deck may be used as a protection against fire. As to poles, in some fires untreated cedar poles were destroyed while creosoted poles were only charred on the surface. Mr. Chanute expressed the opinion, based on long experience, that while freshly-creosoted

timber is [illegible]mmable, after some months it becomes even [illegible]s inflammable than untreated timber. This [illegible]w was supported by other speakers. It has sometimes been claimed that fires on structures have been caused by cinders falling upon creosoted ties or stringers, these being considered especially inflammable. Mr. Buehler referred to examples and experiments which indicate that the hot cinders are more likely to ignite untreated timber than creosoted timber.

INJURY TO EMPLOYEES IN HANDLING TREATED TIMBER.—The preservative medium itself is mainly harmless. Soreness of the eyes and skin may result temporarily, but there is little chance for real injury. However, there is a tendency to attribute injuries to this cause. It was decided to appoint a committee to investigate cases of injury by the action of the preservative at the plant and at the place where the timber is used.

THE OPEN-TANK SYSTEM OF TREATMENT.—Mr. Buehler remarked that this system was generally adapted for cases where it was too costly to import treated timber or where only limited quantities were required. Thus at a mine in a mountain region, where it was necessary to use local timber, the open-tank system might be used to advantage. But it should not be considered as a substitute for the closed-tank or pressure system. A paper on the open-tank treatment was published in our issue of Dec. 31, 1903.

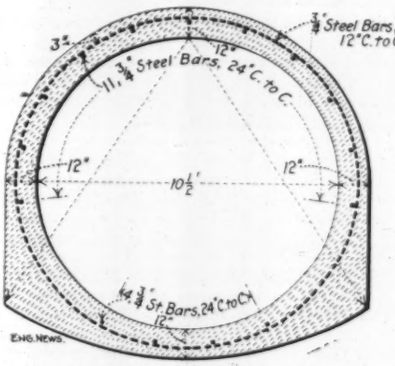
It was voted to appoint a member as assistant to the secretary, with the special duty of taking charge of the program and the securing of papers for the next meeting. The officers for 1909 are as follows: President, Walter Buehler, St. Louis, Mo.; Vice-Presidents, David Allerton, H. P. Valentine and H. M. Rollins; Secretary and Treasurer, C. W. Berry (Union Pacific Ry.), Topeka, Kan. The next meeting will be held at Chicago in January, 1910.

A Concrete Outlet Sewer System for the City of East St. Louis, Ill.

By WILFORD A. THOMPSON,* Assoc. M. Am. Soc. C. E.

The City of East St. Louis will receive bids on Feb. 19, 1909, for the construction of a large concrete outlet sewer system, costing about $700,000, to serve a portion of the city having an area of about 3,800 acres. In 1903 the Mississippi River rose to such a height that only with the greatest effort was it kept from overflowing the city. Steps were immediately taken for permanent protection by levee and drainage (see Eng. News, Nov. 28, 1907). The levee has now been practically completed at a cost of over $200,000. And now, after fighting the case through the courts, the city is ready to commence on the sewers. The present sewer was large enough for this city ten years ago, but as the city has more than doubled in size in the past seven years the present sewers are not large enough to carry the sewage without the rainfall.

The accompanying table shows a few of twenty-two borings made along the lines of the sewer. Rock is at a depth of about 100 ft. The drill used was a 2-in. auger, lengthened with 1¼-in. pipe, turned with a 6-ft. handle by two men. The time given is the total elapsed time.



Section of Proposed Reinforced-Concrete Outlet Sewer, East St. Louis, Ill.

(Same proportioning to be employed for ordinary concrete sewer section.)

The sewer will have a total length of 28,000 ft., in sizes ranging from 4 to 10½ ft. diameter. It is designed to carry something over 600 cu. ft. per sec. at its lower end. The runoff was figured by the formula $Q = 0.8 \text{ area} \times \sqrt{S}$, with a rainfall of 2 ins.

A pumping station will be used about four months of the year, when the river is high. The engines will be vertical single-acting gas engines, direct-connected to a horizontal shaft centrifugal pump. The storm water pumps (five units) are to be not less than 275 brake horsepower at 195 r.p.m., and the sewage pumps (two units) not less than 175 brake horsepower at 240 r.p.m., all when supplied with illuminating gas of 650 B.T.U. per cu. ft. The gas is to be furnished from the local gas company, except that one 500-HP. gas producer is to be provided for.

Mr. W. J. Crocken is the city engineer of East St. Louis, Ill.

*First Assistant City Engineer, East St. Louis, Ill.

BORINGS FOR CONCRETE OUTLET SEWER, EAST ST. LOUIS, ILL.

Hole.	Depth, ft.	Material.	Time.	
1	1	Sand.	1m.	
	16	Gumbo or stiff clay.	2h. 44m.	
	19	Sand & gumbo	3h. 47m.	
2	5	Gumbo.	22m.	
	16	Sand.	4h. 40m.	Water at 15.8 ft.
	24	Quick sand.	13h. 30m.	
3	12	Sand & gumbo	3h. 5m.	
	16	Sand.	4h. 10m.	Water at 12.5 ft.
	25	Quick sand.	10h. 15m.	Drill bent; took 10h. to get out.
4	2	Gumbo.	3m.	Used post auger to 12 ft., then used drill.
	7	Sand & gumbo	22m.	
	12	Sand.	37m.	Water at 7 ft.
	15	Quick sand.	1h. 45m.	
7	6	Clay.	15m.	Post auger to 8 ft.
	19	Sand & clay.	3h. 10m.	Water at 8 ft., rose to 6 ft.
9	8	Clay.	30m.	
	10	Sand.	36m.	Post auger to 10.4 ft.
	15	Quick sand.	60m.	Water at 9.8 ft.
	16	River sand.	69m.	
16	1	Frozen.	45m.	
	3	Gumbo.	72m.	
	10	Sand.	80m.	Water at 10 ft.
	15	Quick sand.	2h. 21m.	
19	7	Clay.	1h. 3m.	
	11	Sand.	1h. 8m.	No water.
	12	Quick sand.	1h. 16m.	
	17	Sand.	3h. 0m.	
22	2	Gumbo.	4m.	
	3	Sand.	5m.	No water.
	10	Sand & gumbo	34m.	
	16	Sand.	62m.	

The Royal Prussian Testing Institute for Water and Sewage Purification.*

By A. ELLIOTT KIMBERLY.†

In 1901, the royal Prussian government established an institute to undertake a thorough study of problems of water and sewage purification, in effect an experiment station where full laboratory facilities would permit of investigations and analyses of all kinds relative to water supply, sewage purification and stream pollution.

While the work of some of the departments in Washington and that of several of the state boards of health is in some respects quite similar, that of this Prussian institution can hardly be said to be duplicated in this country. A short review of the station and its work may be of interest to American readers.

Function of the Institute.

The royal Prussian testing institute of Berlin began operations in April, 1901, with the following general functions:

To investigate the value of current methods of water and sewage purification from a hygienic and from an economic standpoint.

To conduct all necessary investigations relative to the general problem of water and sewage purification at its own instigation.

To make investigations of industrial waste disposal problems when directed by the government, or on request by municipal authorities and for private individuals upon payment of fees.

To give information to central authorities when so directed by the government officials in charge of the institute and to make pertinent reports in the interests of the public.

The special duties of the institute embrace the following additional features:

WATER PURIFICATION.—The systematic examination of current and new methods for obtaining and purifying water, together with a study of the principles which underlie the estimation of water resources and means for their conservation.

The preparation of technical reports relating to proposed or existing water supplies at the request of city and of village officials.

The technical examination of the operation of waterworks plants.

The analysis of water.

SEWAGE PURIFICATION.—The systematic examination of the more important existing and recently proposed processes of sewage treatment, especially with a view to improving existing methods and to developing new ones.

The preparation of schedules of tests for the analysis of sewage and the development of standard methods of analysis.

The preparation of reports on sewerage systems for cities, villages and industrial plants.

The analysis of samples of sewage, garbage and other refuse, soil, filtering materials and chemical precipitants.

The systematic study of the relation of different sewages to the pollution of streams, judging from both a chemical and biological standpoint. The preparation of regulations for the prevention of stream pollution, and in this connection the development of standards of purity for sewage and sewage effluents with special reference to sludge formation, putrescibility, toxicity and insect propagation.

The supervision of the requirements of local authorities regarding the operation of sewage purification plants, particularly with regard to the rights of all parties concerned.

The determination of the effect of sewage on soil, the persistence of its fertilizing power and the degree of purity required of land effluents.

Departments of the Institute.

The work of the institute is carried out by four separate departments—engineering, chemical, bacterial and zoological—all of which are under the general direction of the chief royal health officer, who has entire administrative charge of the institute. Assisting him is a commission of nine members, including one each from the departments of public health, interior, agriculture, domain, forestry, commerce and labor, public works and the treasury.

The institute is in direct charge of a director, a chief of staff and an assistant chief, each of whom is appointed by the chief royal health officer. At the present time the scientific staff includes 27 persons, together with a clerical force of nine members. The personnel and work of the different departments are as follows:

ENGINEERING.—The engineering department consists of a chief engineer, two assistant engineers, one architect and one engineering assistant. Its work is chiefly the examination of plans for water and for sewage purification plants.

CHEMICAL.—The chemical department consists of a chief chemist, four associates and six assistant chemists. The work of the department is largely the physical and the chemical examination of samples of water, sewage, refuse, etc., supplemented by reports relative to the interpretation of the chemical data.

BACTERIAL.—The bacterial department consists of a chief bacteriologist, two associates and several assistants. Its work is chiefly the examination of water purification and sewage treatment plants in conjunction with the engineering department.

ZOOLOGICAL.—The zoological department consists of three associates and one assistant. Its work is chiefly the biological and microscopical examination of water, sewage, sludge and similar material.

General Features.

Since the work of the four departments is so closely interrelated, it is especially desirable that the station staff shall become familiar with all the work of the institute.

This important feature in developing a well-balanced corps of assistants is accomplished by holding regular conferences in which there is afforded an opportunity for all persons connected with the station to express their views regarding the problems in hand. These conferences, no doubt, serve to broaden the reports prepared by the institute, since they admit of a very much wider viewpoint than when prepared by individuals. As further aid in the preparation of reports, the institute has a well-equipped library which contains over 4,000 books. In addition,

*Based on a description by Dr. Klut, in Prussian "Verwaltangsblatt," Vol. XXIX., No. 44 (Date, 1908).

†Assistant Engineer, Ohio State Board of Health, Columbus, O.

the institute subscribes to about 60 periodicals, including 10 foreign journals.

Scope and Nature of the Institute Work.

Concerning the scope of the work of the institute, the following table shows some interesting data which indicate the very rapid development of the station since its founding in 1901.

Year.	Number of reports.	Number of samples analyzed.
1901	121	910
1902	280	1,124
1903	248	1,297
1904	362	1,546
1905	367	1,482
1906	350	1,882
Total	1,728	8,241

Besides work on special problems, the institute undertakes the regular examination of the water supplies of railroads and large corporations and the continuous control of the operation of water and sewage purification plants. It also gives advice to large engineering firms and offers its laboratory facilities for chemical and for bacterial analyses. An account of the work of the institute is published in unbound volumes, entitled "Mitteilungen aus der Koniglichen Prufungsanstalt fur Wasserbesorgung und Abwasserbeseitigung," of which, from 1901 to 1908, there have appeared ten reports. While for details of the subjects treated, reference must be made to the reports themselves, it is of interest to refer briefly to some of the more important studies.

The engineering department has made an extended examination of the more important English sewage purification plants, an account of which is contained in Volume III. of the reports of the institute. It has further made a special study of manufactural wastes treatment and of water purification, using chloride of iron as a coagulant, and it has also been conducting experiments in cooking sewage sludge.

The chemical department has developed standard methods for water and sewage analysis, regarding which there have been published a number of important papers. It has paid considerable attention to problems of water purification, such as iron removal, manganese removal, decolorization and water softening. Considerable research has been directed toward the disposal of sludge, and some experimental work has been carried out on sewage purification methods, especially a series of large-scale tests at Charlottenburg, near Berlin. This department has also investigated the treatment of garbage and other refuse, particularly from the viewpoint of by-product recovery.

The bacterial department has contributed considerable data regarding methods of bacterial analysis, the disinfectant power of ozone in water purification and the significance of B. coli in water.

The biological department has in turn developed the general principles of the biological analysis of water, has studied the algal flora in sewage and has investigated rivers, lakes and water purification plants from a biological standpoint.

The expenses of the institute are annually about $35,000, of which $23,000 are for salaries and $12,000 for supplies and apparatus. The receipts from reports and analyses average annually about $15,000.

THE HIGH-PRESSURE WATER-SUPPLY SYSTEM for fire protection in Brooklyn will be extended at a cost of $1,200,000, if recommendations made by Mr. William C. Cozier, Deputy Commissioner of Water Supply, Gas and Electricity, are carried out. The territory covered by the extension recommended lies between the Navy Yard and Newtown Creek, and Erie Basin and 65th St., Bay Ridge. The territory at present covered includes some 1,300 acres, and extends along the East River water front from Erie Basin to the Navy Yard, reaching inland from a few hundred feet at the southern end to about a mile at the northern end.

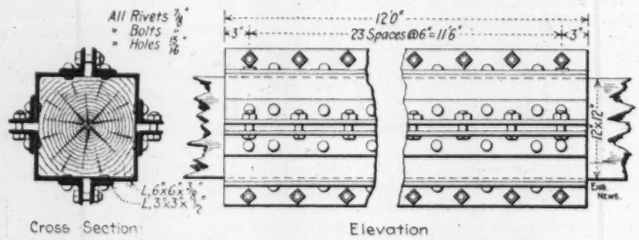
Sectional Gin Poles for Steel Stack Erection.

By W. E. GOLDSWORTHY.*

Modern improvements in the methods and materials used in rigging, make it possible to handle in one piece objects of a weight and size hitherto considered unmanageable, and which would need to have otherwise been built in place at a great increase in cost and time required.

Under this head come steel smokestacks which until the last few years were usually built in place one plate at a time when they exceeded say 48 ins. in diameter by 100 ft. high. It is now the usual practice among up-to-date builders to ship a stack in long sections, to assemble it in one piece on the ground, and then to raise it with one or more gin poles.

As far as the writer knows, practically all riggers use one-piece gin poles, there seeming to be a prejudice against spliced or sectional rigs. The Dover Boiler Works, of Dover, N. J., who are among the largest builders in the East of stack work of this character, realizing the delay and expense entailed in moving a pair of 70-ft. poles around the country, designed and built a pair of sectional gin poles each with a total height of 92 ft. and a lifting capacity of 10 tons. They are made from the best long-leaf yellow pine, being 12 × 12 ins., their entire length, each pole being comprised of two 36-ft. lengths and one 20-ft. length. The splices are made with angles arranged as shown in the accompanying sketch, each splice being in four duplicate parts joined by ⅞-in. bolts 6 ins. c. to c.



SPLICE FOR 12 x 12-IN. YELLOW-PINE GIN POLES.

The lengths of the sections of poles used permit of shipping on an ordinary gondola car usually with part of the stack. In most cases the two 36-ft. sections are all that it is necessary to use, it being possible with these to lift a 150-ft. stack in one piece if it is made with the bottom half heavier than the top half. Very frequently, however, it is necessary to use the poles full length, it being exceptionally useful on long light stacks which are raised say in 30 or 35-ft. lengths. In Engineering News of Oct. 22, 1908, is shown a view of these two poles with the four 36-ft. lengths only, lifting a stack 72 ins. × 105 ft. at the plant of the Crocker-Wheeler Co., Ampere, N. J. The illustration gives a very good idea of the actual appearance of the splices in service. They were designed so that the poles would fall outside of the splices, if failure ever occurred. Among the features which commend this form of splices are these: (1) No holes are bored in the timbers; (2) the ends of timbers need not abut; (3) any section of poles or any splice is interchangeable with any other; (4) if loads beyond the normal capacity of the poles are to be raised, truss rods may be attached to the splices with great convenience.

A SNOWSLIDE IN COLORADO, Jan. 22, swept over the camp of the Camp Bird mine at Ouray. Four men were killed. The slide is said to have involved several thousand tons of snow, earth and rock.

THREE EXPLOSIONS OF DYNAMITE in powder works, resulting in a total of five deaths, have recently been reported. An explosion in one of the buildings of the Consolidated Fireworks Co. of America, at Reading, Ohio, near Cincinnati, Jan. 13, wrecked the building and killed the only employee who was in it at the time, a boy of 15 years.

An explosion at the dynamite cartridge house of the forcite works of the D. E. DuPont de Nemours Powder Co. on the east shore of Lake Hopatcong, N. J., Jan. 20, wrecked the building, a one-story [illegible] and killed the four men who were in [illegible] employees were injured.

Several small corrugated iron buildings [illegible] the Du Pont powder works at Gibbstown, N. J., were wrecked Jan. 20 by an explosion in the mixing build[illegible] were injured.

A FLOOD IN THE TRANSVAAL, Jan. [illegible] resulted in the death of 173 persons. The flood was due to heavy rains which caused the bursting of Kn[illegible] dam. The water released from the dam flooded the [illegible]watersrand gold mine, drowning 160 miners, and s[illegible] away several houses in the lower sections of the t[illegible] of Elsburg, where 13 persons were drowned.

A FIRE ON THE GALVESTON WHA[illegible]S. Jan. 22, entirely destroyed Piers 12 and 13, to[illegible] with the contents of the pier sheds. The fire is sa[illegible] have been caused by the explosion of a watchma[illegible] lantern on Pier 12. The loss is estimated at $450,000.

THE CHICAGO AND ST. LOUIS EX[illegible]SS on the Pennsylvania R. R. was wrecked Jan. 23, at Summerhill, Pa. Three persons, one a passenger, were killed, and seven others injured. The wreck was the result of a rear-end collision between the first and second sections of the train. The first, or Chicago, section had been stopped by a freight train ahead of it which in turn had been obliged to stop to remove some fallen rocks from the track. The dense fog obscured the block signal lights and the St. Louis section, drawn by two locomotives, crashed into the rear of the Chicago section. The rear parlor car was completely demolished, but fortunately, it contained only one passenger and the Pullman conductor and porter, these three being killed. The other cars of the first section were derailed, as were also the two locomotives and first two express cars of the second section.

THREE COAL MINE ACCIDENTS have been reported during the past week. An explosion in the Cyclone Canon mine near Chancellor, Cal., 70 miles south of Salinas, Jan. 19, killed six of the miners.

An accident on the inclined plane railway of the Piedmont & George's Creek Coal Co. at Piedmont, W. Va., Jan. 25, resulted in the death of three miners and the injury of as many others. The men were riding up the incline in two cars coupled together and were struck by a descending car loaded with coal. The collision is ascribed to the failure of the automatic switch at the passing siding halfway up the incline.

An explosion of gas in the coal mine of the Merchants' Coal Co., at Boswell, Pa., Jan. 25, imprisoned about 15 miners. Later reports state that only one is known to have been killed and that all but two of the others have been rescued.

The total number of victims of the explosion at the Lick Branch mine, Jan. 12, is now given as 65. The coroner's jury exonerated the mine company from all blame, ascribing the explosion to an overcharged shot of gunpowder.

DESTRUCTIVE FLOODS IN CALIFORNIA resulted from the combination of heavy rains throughout the Sacramento valley and the melting of snow in the mountains due to the warm weather of Jan. 14 to 22. Traffic has been seriously interfered with and in some cases entirely suspended owing to track washouts and the destruction of railway bridges.

Similar conditions are reported in Washington. Spokane is said to have been cut off from rail communication to the west and south.

A FIRE IN A TEMPORARY SHAFT-CRIB being used to construct a new water-supply tunnel under Lake Michigan, at Chicago, on Jan. 20, caused about 60 men to lose their lives by fire or by drowning. The new Southwest intake tunnel extends under the lake from 73d St., and will be about 12,180 ft. in length, as described in our issue of Nov. 14, 1907. An intermediate crib was built about 7,500 ft. from shore, in deep water, covering a working shaft from which drifts are being driven towards the shore shaft and the permanent intake shaft. A timber superstructure contained the air compressors and other machinery, a powder room for the storage of small quantities of explosives (the main supply being kept in a powder-house near the shore), and living accommodations for a large number of men. An aerial tramway provided means of transporting men and materials between the shore and the crib. On Wednesday morning, Jan. 20, about 100 men were on the crib; some were at breakfast, others were in their bunks, and others were employed in various ways. When the fire was discovered it was so hot and spread with such rapidity that there was no chance for the men to attempt to fight it. Some of the men jumped onto a pile of debris at the side of the crib. Others jumped into the water, and some of these found support on the floating ice, and were rescued, but it appears evident that a number were drowned. A few went down the shaft and somehow escape

*Assistant Manager, Dover Boiler Works, Dover, N. J.

in the drifts, but most of these were killed by suffocation. The great number of the men, however, were burned in the substructure of the crib. A tug belonging to the contractors was near at hand and helped in the rescue, and the city's fireboats were sent to the scene. The aerial tramway was put out of service by the falling of the temporary supports at the crib. The fire was so fierce that the bodies of the men were partially destroyed, and it was a difficult matter to determine the number of bodies. The remains had to be placed in sacks for removal to the city. The bodies recovered numbered 53, and up to the morning of Jan. 25, but the list of the missing was about 60, and it is probable that many of the men who jumped into the lake were drowned.

The cause of and responsibility for the accident have not been determined. Three causes have been mentioned: (1) the use of gasoline to kill vermin in the bunk room, the vapor being ignited by a hot stove; (2) the carrying of a torch into the powder room by a miner; (3) smoking by men in the bunk room. It is claimed that precautions had been taken against fire, but the city appears to have exercised no supervision over the construction or equipment of the structure. The fire department, however, at one time investigated complaints against the quantity of explosive stored, but appears to have found the conditions satisfactory. An investigation is being made, and it is stated that it will include the relations of the city departments to the work. In order to have expert assistance, three engineers have been included in the coroner's jury (A. Bement, John M. Ewen and Benezette Williams).

It may be noted that the construction of the submarine tunnels which form the intakes for the water supply of several of the large cities on the Great Lakes has been attended with numerous difficulties and some serious accidents. The most serious previous accidents have been at Cleveland, as noted in our issues of Aug. 29, 1901, and Dec. 18, 1902. About 60 men in all were killed on that work. The various engineering difficulties encountered at the Chicago tunnels were reviewed in our issues of Oct. 18 and Nov. 8, 1900. In the new tunnel it is designed to avoid these by constructing it at such a depth as to lie entirely in the solid rock.

THE STEAMER "REPUBLIC" of the White Star Line was sunk Jan. 24 as the result of a collision with the "Florida" of the Lloyd-Italian Line. Three of the "Republic's" first-cabin passengers and three seamen in the forecastle of the "Florida" were killed by the collision. The accident occurred at about 4 a. m., Jan. 23, during a dense fog. The "Florida" was inward bound and is believed to have lost her bearings on account of the long-continued fog. She struck the "Republic," outward bound in the regular course, on the port side abaft the beam, crushing two of the "Republic's" bulkheads. The stem of the "Florida" was seriously damaged, but she was able to take on board the 460 passengers of the "Republic" and eventually reached port under her own steam, convoyed by the "New York." The "Republic" was in constant wireless communication with other liners and with stations on shore. The "Baltic," "Lucania," "Furnessia," "New York" and "Lorraine" started a search for the damaged vessels. The "Baltic" was the first to reach the "Florida," which has no wireless apparatus, and took on board all her passengers, including those of the "Republic." The total number of passengers transferred was 1,650 and the time required was about ten hours. The transfer was made in open boats with the two vessels lying about one mile apart.

The captain and crew of the "Republic" remained with their ship, and the "Furnessia" and the revenue cutter "Gresham" attempted to tow her into port. Towing was begun shortly after noon on Jan. 24 and the injured ship sank suddenly at 8:40 that evening, 40 hours after the collision. She went down in 45 fathoms of water near No Mans Land, about 30 miles west of Nantucket. The captain and crew were rescued by boats from the "Gresham."

AN EARTHQUAKE IN TURKEY Jan. 19 destroyed more than 300 dwellings and killed about ten people in the vicinity of Phocoea, 25 miles northwest of Smyrna. Continual earth shocks have been recorded in Europe and America since the disaster at Messina, Dec. 28. Slight shocks have been felt in Italy, France, Austria, Greece, Spain and in Mexico, Maryland, Tacoma, Wash., and Vancouver, B. C.

A submarine volcanic eruption was reported Jan. 1 off the coast of Georgia. On Jan. 20, the volcano near the city of Colima, Mex., was reported to be in eruption, emitting ashes and pumice but no lava. An eruption of Mount Lagnas, P. I., Jan. 19, released the waters of a mountain lake which flooded several streams and ravines and caused a loss estimated at $50,000 to plantations, bridges and roads. It is reported that only one person was killed by the flood.

Recent estimates of the loss of life in the earthquake in Calabria, Italy, which was noted in our issue of Dec. 31, 1908, place it at about 160,000.

A GRANT OF PERPETUAL RIGHT TO A WATER power was condemned in a veto by President Roosevelt on Jan. 16. The bill in question authorized one William H. Standish to construct a dam across James River, in Stone County, Mo., for the development of water-power. The President's veto message was based on similar grounds to his veto message of April 13, 1908, relating to a bill for the construction of a dam across the Rainy River, in Minnesota. After reviewing the legal right of the Federal Government to so restrict its grants for the use of water-power as to prevent a perpetual monopoly being created, the President continues:

The people of the country are threatened by a monopoly far more powerful, because in far closer touch with their domestic and industrial life, than anything known to our experience. A single generation will see the exhaustion of our natural resources of oil and gas and such a rise in the price of coal as will make the price of electrically transmitted water-power a controlling factor in transportation, in manufacturing, and in household lighting and heating. Our water-power alone, if fully developed and wisely used, is probably sufficient for our present transportation, industrial, municipal, and domestic needs. Most of it is undeveloped and is still in national or state control.

To give away, without conditions, this, one of the greatest of our resources, would be an act of folly. If we are guilty of it, our children will be forced to pay an annual return upon a capitalization based upon the highest prices which "the traffic will bear." They will find themselves face to face with powerful interests intrenched behind the doctrine of "vested rights" and strengthened by every defense which money can buy and the ingenuity of able corporation lawyers can devise. Long before that time they may and very probably will have become a consolidated interest, controlled from the great financial centres, dictating the terms upon which the citizen can conduct his business or earn his livelihood, and not amenable to the wholesome check of local opinion.

In support of the position thus taken, the President quotes information collected by the Bureau of Corporations and other government bureaus regarding the control of water powers by large financial interests. It is stated that 13 large concerns, of which the General Electric and the Westinghouse Companies are the most important, now control water-power plants and power plant sites aggregating about 1,046,000 HP. This is about 19% of the total water power of the United States now developed. Besides these plants and sites where the control is well known there are other plants where the evidence of inter-corporate relation is such that there is strong reason to believe that these 13 concerns are also the parties chiefly interested. This raises the total proportion of the water powers under the control of these few corporations to 33% of the total water power now in use.

The proposal of the President is that, instead of giving grants to water-power companies in perpetuity, franchises be issued for a limited term, not to exceed 50 years, and irrevocable except for breach of the stated conditions. He quotes also the principles laid down in his veto of the Rainy River bill, which should govern the policy of the nation in granting rights for water-power development, and says:

I esteem it my duty to use every endeavor to prevent this growing monopoly, the most threatening which has ever appeared, from being fastened upon the people of this nation. I will sign no bill granting a privilege of this character which does not contain the substance of these conditions. I consider myself bound, as far as exercise of my executive power will allow, to do for the people, in prevention of monopoly of their resources, what I believe they would do for themselves if they were in a position to act.

Concerning the manner in which the great water-power corporations are working to obtain control by perpetual grants of undeveloped powers, the following quotation from the message is of interest:

The great corporations are acting with foresight, singleness of purpose and vigor to control the water powers of the country. They pay no attention to state boundaries and are not interested in the constitutional law affecting navigable streams except as it affords what has been aptly called a "twilight zone," where they may find a convenient refuge from any regulation whatever by the public, whether through the National or the State governments. It is significant that they are opposing the control of water power on the Desplaines River by the State of Illinois with equal vigor and with like arguments to those with which they oppose the National Government pursuing the policy I advocate. Their attitude is the same with reference to their projects upon the mountain streams of the West, where the jurisdiction of the Federal Government as the owner of the public lands and national forests is not open to question. They are demanding legislation for unconditional grants in perpetuity of land for reservoirs, conduits, power-houses and transmission lines to replace the existing statute which authorizes the administrative officers of the Government to impose conditions to protect the public when any permit is issued. The new legislation sought in their own interest by some companies in the West, and the opposition of other companies in the East to proposed legislation in the public interest, have a common source and a common purpose. Their source is the rapidly growing water-power combination. Their purpose is a centralized monopoly of hydro-electric power development free of all public control. It is obvious that a monopoly of power in any community calls for strict public supervision and regulation.

A FEDERAL FINE ARTS COUNCIL has been appointed by President Roosevelt to supervise the choice of sites, design and erection of all government structures. This body, which is composed of 21 architects, four painters, four sculptors, and one landscape architect, all of national reputation, is to serve, without compensation so far as is indicated in the executive order, as a supervisory board to pass upon the artistic qualifications of such buildings, statues or monuments as the government may build. The council was formed, at the suggestion of the American Institute of Architects, not only to provide some regulated plan to be followed in public works, but also to ensure a proper appreciation of artistic individual and collective designs. The main portion of the order reads as follows:

Hereafter, before any plans are formulated for any buildings or grounds, or for the location or erection of any statue, the matter must be submitted to the council named and their advice followed, unless for good and sufficient reasons the President directs that it be not followed.

The supervising architect of the Treasury will act as the executive officer for carrying out the recommendations of the council.

Such an order cannot remove from Congress the initiative in all matters pertaining to government construction. The council has no original authority to build; all it can do is to advise on the construction of such works as are authorized by Congress. The details of administration have not as yet been announced.

THE IROQUOIS THEATER AND THE DARLINGTON collapse figured in court decisions as to damage liability recently. In the Iroquois fire case, press dispatches from Chicago report suits directed against the George A. Fuller Construction Co. as codefendants were ordered discontinued, and proceedings for settlement of claims begun by them. This represents the first reported step in payment of damages for the several hundred lives lost in the burning out of the fireproof Iroquois Theater in Chicago. In the case of the Darlington Hotel collapse in New York City, where twelve stories of cast-iron and steel frame and concrete floor collapsed, the court of last resort is reported to have affirmed a judgment holding the concrete contractor jointly liable. In neither the Darlington nor the Iroquois case did the criminal prosecutions lead to any result.

THE INDIAN CREEK WATER-SUPPLY SYSTEM of the Pennsylvania Railroad, described at length in our issue of April 9, 1908, has been used to supplement the supply of the Westmoreland and Irwin Water Companies at Greensburg, Pa., and vicinity. The long-continued drought had nearly exhausted the supply of these companies and was endangering the life and property of some 35,000 people. The supplementary supply is furnished without charge, for reasons stated in the following extract from a letter written by Mr. James McCrea, President of the Pennsylvania R. R. Co., to Mr. Murray Forbes, Secretary and Treasurer of the Westmoreland and Irwin Water Companies' system at Greensburg, Pa.:

As a question might be raised as to the right or power of this company to do so, I am unwilling to sell to your companies any of the water secured from our own supply, but realizing the dangers and discomforts to which such a large population are exposed we feel that we must, regardless of apparent difficulties, do our best to be of assistance, and therefore, with a clear understanding that no right or precedent is established by the action, the Pennsylvania R. R. Co. will, while the present emergency exists, give to your company free of charge such quantity of water as we can in our judgment safely spare, with the understanding, however, that such water is in turn to be given by your companies free of charge to the consumers.

THE INTERNATIONAL EXHIBITION OF LATEST inventions is to be held at St. Petersburg, Russia, May 5 to June 23, 1909, in the Michael Manege. The exhibition will be of a semi-official nature and has been organized by the Society of Military, Maritime and Rural Science under imperial patronage. The range of exhibits will include military and naval technics, agricultural science, means of communication, construction work, new industrial and factory appliances, electrical appliances, household novelties and improvements in fire-fighting apparatus. New inventions in the fine arts, medicine, sports, etc., have also been included in the program.

THE SITE FOR THE NEW AUSTRALIAN CAPITAL.—During the past month the long-contested question as to the locality of the new capital of the Australian Commonwealth was settled by the choice of the Federal Parliament of the Yass-Canberra district in New South Wales as the Federal Territory within which the capital is to be situated. The further selection within this district of some 800 square miles of a suitable site for the new city is somewhat limited by the fact of the main line of railway between Sydney and Melbourne touching only one corner of the new Federal Territory, and it being practically essential that the city should adjoin this line. Many engineering, architectural, and other considerations will be involved, both in the selection of the site, and in the design of the new bush capital. It will be remembered that two of the main conditions governing the selection of the site for the new capital were that it was to be within the State of New South Wales, and not less than 100 miles from Sydney. Some

discussion turned on the meaning of 100 miles, one party urging that it should be measured by the shortest existing main road or railway, and the other that it was to be measured as the crow flies; the latter reading was accepted. We may repeat, as some confusion has arisen about the point, that Yass and Canberra are two distinct places some distance—about 30 miles—apart, and not one, as some reports would leave one to believe. The double name, Yass-Canberra, indicates the territory in which these two places are included, and is used as a matter of convenience.—"The Engineer."

AN EIGHT-HOUR DAY LAW FOR BRITISH MINE laborers was enacted by Parliament in December, 1908. The bill will come in force on July 1, 1909, except in the Northumberland and Durham districts, where it will become effective six months later. The following unfavorable view of this bill, expressed by our London contemporary, "The Engineer," may interest some of our readers:

It is a measure pernicious in itself, in spite of the amendments made in the upper House, but it is doubly bad as introducing a principle which is wholly against the best British traditions. The laws that exist for the regulations of trade have hitherto been directed almost wholly to the protection of young people and women who it was considered were unable to look after themselves, or to the regulation of admittedly dangerous or unhealthy trades. The Mines Bill is devised to guarantee leisure to a class of men who already take holidays whenever they please, are notoriously not hard workers, and are thoroughly well able to look after themselves; and to ensure health in a trade which all statistics show to be far from insalubrious. It is not difficult under the circumstances to believe that political wire-pulling has had not a little to do with the passage of the bill. The only amendment of importance made by the Lords and accepted by the Commons was that the statutory eight hours should be exclusive of both windings. It may therefore be taken that the time has been raised from 8 to 8½ hours. The gain of half an hour is a matter of some importance.

Personals.

Mr. E. Ben Carter has been appointed Superintendent of Maintenance of Way of the Florida East Coast Ry.

Mr. Newman Erb has been elected President of the Wisconsin Central Ry., succeeding Mr. W. O. Bradford, resigned.

Mr. R. F. Leefeld has become Chief Engineer of the Temescal (Cal.) Water Co., succeeding Mr. Richard Nelson, resigned.

Mr. A. B. Fall, General Counsel of the Sierra, Madre & Pacific R. R., has become President of that line, succeeding Mr. H. R. Nickerson.

Mr. Robert Mather, President of the Rock Island Co., has been elected President of the board of directors of the Westinghouse Electric & Mfg. Co.

Mr. George N. Comly, M. Am. Soc. M. E., Chief Draftsman for the Solvay Process Co. at Syracuse, N. Y., has tendered his resignation, effective March 1.

Mr. Benjamin E. Tilton has been appointed Engineer of Maintenance of Way of the Municipal Traction Co., of Cleveland, Ohio, to succeed Mr. R. H. Bunning, resigned.

Mr. John J. Sullivan, Traveling Engineer of the Cincinnati, Hamilton & Dayton Ry., has been appointed a member of the State Railway Commission of Ohio by Governor Harmon.

Mr. Frank W. Morse, Vice-President and General Manager of the Grand Trunk Pacific Ry., has resigned. He will be succeeded by Mr. Edson J. Chamberlain, formerly General Manager of the Canada Atlantic Ry.

Mr. Arrow C. Hankins, of Jamaica, N. Y., has been appointed Superintendent of Street Cleaning in the Borough of Queens, New York City, to succeed Mr. James E. Clonin, resigned.

Mr. P. A. McCarthy, Chief Engineer of the Groveton, Lufkin & Northern Ry., has resigned to take a similar position with the San Diego, El Paso & St. Louis R. R. with headquarters at El Paso, Tex.

Mr. Reginald Meeks, M. Am. Inst. M. E., has resigned his position on the staff of the "Engineering and Mining Journal" to take charge of Dr. Charles T. Hennig's testing and research laboratory in Brooklyn, N. Y.

Mr. J. F. Munn will take charge of the office of the Cyclone Drill Co., recently opened at 419 Fisher Bldg., Chicago, Ill. Mr. R. R. Sanderson will succeed Mr. Munn as Manager of the core drill department at Orrville, Ohio.

Mr. Claire M. Belding, Assistant City Engineer of Cleveland, Ohio, in charge of harbor, wharf and river improvement for the past four years, has resigned to take charge of the canal bulkhead work being carried on by Ohio State.

Mr. T. L. Burton, General Inspector of the Central R. R. of New Jersey, has been appointed General Inspector of the Philadelphia & Reading Ry. and the entire Reading system in charge of air brake, steam heat and car lighting equipment.

Mr. Wilson T. Howe, in the employ of Engineer Office of the U. S. Army at Cleveland, Ohio, for the past six years in local charge of various harbors in that district, has been transferred to the Philippine Service. He will sail from San Francisco Feb. 4.

Mr. Edward I. Clawiter, heretofore Chief Engineer at Manila, P. I., of the Atlantic, Gulf & Pacific Co., has been transferred to the New York office of that company. Mr. H. P. Linnell, Assoc. M. Am. Soc. C. E., will succeed Mr. Clawiter as Chief Engineer at Manila.

Mr. J. W. Metcalf, Assistant Superintendent of the Southern Pacific Ry., has been transferred from the Los Angeles to the Tucson division. He will be succeeded at Los Angeles by Mr. A. M. Jamison, formerly Chief Clerk in the office of the general superintendent.

Mr. Frank N. Kondolf, President of the American Sewer Pipe Co., has resigned to become President of the Stromberg-Carlson Telephone Mfg. Co., of Rochester, N. Y. He will be succeeded as President of the pipe company Feb. 1 by Mr. Geo. H. Hill, now Vice-President.

Mr. W. S. Martin, Assistant General Manager of the Denver & Rio Grande R. R., has assumed the duties of the office of General Superintendent made vacant by the withdrawal of Mr. A. E. Welby (Eng. News, Oct. 8, 1908). The position of General Superintendent has been abolished.

Mr. Onward Bates, President Am. Soc. C. E., and Mr. Samuel Higgins, General Manager, New York, New Haven & Hartford R. R., are among those who will make addresses at the 45th annual convention of the Theta Xi fraternity in New York City Feb. 19-20. Mr. Wm. H. Wiley, M. Am. Soc. C. E., will preside at the convention, and Mr. J. A. Knighton, M. Am. Soc. C. E., with Mr. Henry W. Hodge, M. Am. Soc. C. E., will conduct an excursion to inspect the Blackwell's Island Bridge. Mr. Knighton is Engineer in Charge of Construction of the bridge and Mr. Hodge was recently engaged by the City of New York as a consulting engineer to recompute the stresses.

Obituary.

George W. Shotwell, President of the Diehl Electric Mfg. Co., of Elizabethport, N. J., died Jan. 21 of hemorrhage at his home in Bayonne, N. J.

Charles H. Dutton, Assoc. M. Am. Soc. C. E., died Jan. 17 at Haverhill, Mass. He was formerly a granite and marble contractor and was at one time employed in the Engineer Corps of the U. S. Army. He was 75 years old.

William G. Park, chairman of the board of directors of the Crucible Steel Co., died at his home in Pittsburg, Pa., Jan. 19. He was born in Allegheny, Pa., in 1849, and was educated at the Western University of Pennsylvania and the Renssalaer Polytechnic Institute.

Norman F. Pedley, Stud. Can. Soc. C. E., who was employed as a surveyor by the Illinois Traction System, died at Springfield, Ill., Jan. 18. His death was the result of his being struck by a train several days before on the Chicago & Alton tracks five miles south of Springfield. Mr. Pedley was a graduate of McGill University and was about 24 years old.

George Adgate, M. Am. Soc. C. E., died at Kansas City, Mo., Jan. 23 aged 64 years. He was well known by bridge constructors as having a remarkably successful record as manager of bridge foundation work, having had charge of many important foundations on the large rivers of the United States. At the time of his death he was Western manager for the Foundation Co. of New York, with headquarters at Kansas City.

Lucius T. Gibbs, Electrical Engineer of the Baltimore & Ohio R. R., died at his home in Green Spring Valley, Pa., Jan. 22. Mr. Gibbs was born in 1869 and graduated at Cornell University in 1891. He was at one time assistant to the Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry. and was afterward Electrical Engineer of the Milwaukee Street Ry. and Vice-President and Chief Engineer of the Gibbs Electric Co., of Milwaukee. During the Spanish-American War he was an assistant engineer on board the "Newark" and was afterward transferred to the "Brooklyn."

Engineering Societies.

COMING MEETINGS.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 1-6. Annual convention at Rochester, N. Y. Secy., T. A. Randall, Indianapolis, Ind.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 9. Annual meeting at Hartford, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

NEW ENGLAND GAS ASSOCIATION.
Feb. 17-18. Annual meeting at Boston, Mass. Secy., N. W. Gifford, East Boston Gas Co., East Boston, Mass.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 23. Annual meeting at New Haven, Conn. Secy., R. W. Raymond, 29 West 39th St., New York City.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.
March 2-4. Annual convention at Minneapolis, Minn. Secy., J. C. Van Doorn, 836 Security Bank Bldg., Minneapolis, Minn.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 16-18. Annual convention at Chicago. E. H. Fritch, 962 Monadnock Block, Chicago, Ill. Secy.

WESTERN RAILWAY CLUB.—At the regular monthly meeting in Chicago, Jan. 19, a paper was presented by Mr. Eugene McAuliffe on "The Purchase of Railway Fuel Coal."

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the annual meeting in Pittsburg, Jan. 19, officers were elected as follows: President, Geo. T. Barnsley; Vice-President, Walther Richards; Treasurer, A. E. Frost; Directors, S. A. Taylor and N. Chester.

OKLAHOMA ENGINEERING SOCIETY. At the annual meeting held recently in Guthrie, Okla., the following officers were elected: President, H. V. Hiley, Supervising Engineer, Sulphur, Okla.; Vice-Presidents, F. C. Hand, Chief Engineer, Oklahoma Central Ry.; E. E. Colby, City Engineer, Chickasha, Okla., and E. E. King, Stillwater, Okla.; Secretary and Treasurer, B. Merry, Stillwater, Okla. A semi-annual meeting will be held at Tulsa, Okla., June 7, 1909.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago on Jan. 20, a paper on "Steel Castings," by Mr. James C. Davis, of the American Steel Foundries Co., was read by the secretary. One of the important features in this work is the special formation of the molds, in view of the relatively high temperature of the steel and the resultant great rate of shrinkage. A locomotive frame 30 ft. long and weighing about 9,000 lbs. will shrink about 6 ins. These frames are cast in thoroughly dried molds which offer great resistance to shrinkage; the contraction will be localized in the form of cavities where ample risers or sinking heads are provided to feed metal to provide for the deficiency. These risers must contain an amount of metal equal in the aggregate to 30% or 50% of the metal in the casting.

Steel castings are being extensively used in bridge work, machinery and shipbuilding, and range from small pieces to huge castings weighing many tons. Thus the "Lusitania" of the Cunard Line has a cast-steel stem weighing 8.3 tons and a cast stem stern post weighing 59.4 tons. In locomotives, steel castings are used for wheel centers, frames, pistons, cylinder heads, etc. Annealing is generally considered desirable, in order to eliminate stresses due to unequal cooling and resistance in the molds.

Mr. Warder referred to the melting of steel in converters and open-hearth furnaces. The latter have many advantages, particularly in the capacity, the tonnage that can be secured in one melt, and the fairly uniform chemical composition. The period during which the steel may be poured is sufficiently long to give opportunity to determine in advance of the cast the chemical character of the metal, and to modify its character if necessary.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.—The tenth annual convention will be held in the Auditorium Hotel, Chicago, March 16-18. An exhibition of railway appliances will be in progress at the Coliseum during the convention. Among the committee reports to be presented are the following:

Roadway,—track elevation and depression in cities, protection from slides and washouts, surface and subsurface drainage.

Ties,—present and future status of the tie supply, extent of use of metal and composite ties.

Rail,—failure of rails, specifications for drop testing machine.

Buildings,—coaling stations, reinforced concrete for coaling stations and storage bins, reinforced-concrete roofs for roundhouses, ventilation and heating of roundhouses.

Wooden Bridges and Trestles,—specifications, safe unit stresses and standard names for structural timbers, principles and methods of pile driving.

Masonry,—failures of concrete structures, waterproofing of masonry, retaining walls, monolithic construction in arches or large abutments with wing walls, specifications for reinforced concrete.

Signaling and Interlocking,—mechanical and electrical interlocking specifications, rubber-covered wire specifications, description of a comprehensive system of universal signaling.

Water Service,—motive power for pumping plants, typical installations for various conditions, designs of typical installations of track tanks.

Iron and Steel Structures,—inspection and maintenance of bridges, specifications for bridge erection, steel bridge construction compared with reinforced concrete for main girders carrying heavy loads under high speeds.

Wood Preservation,—processes, methods and results obtained.

Special committees will report on the injury to bridges and railway structures due to flat spots on car wheels; on the injury to signals, bridges and track due to brine drippings from refrigerator cars; and on the effect of moving loads on railway bridges.